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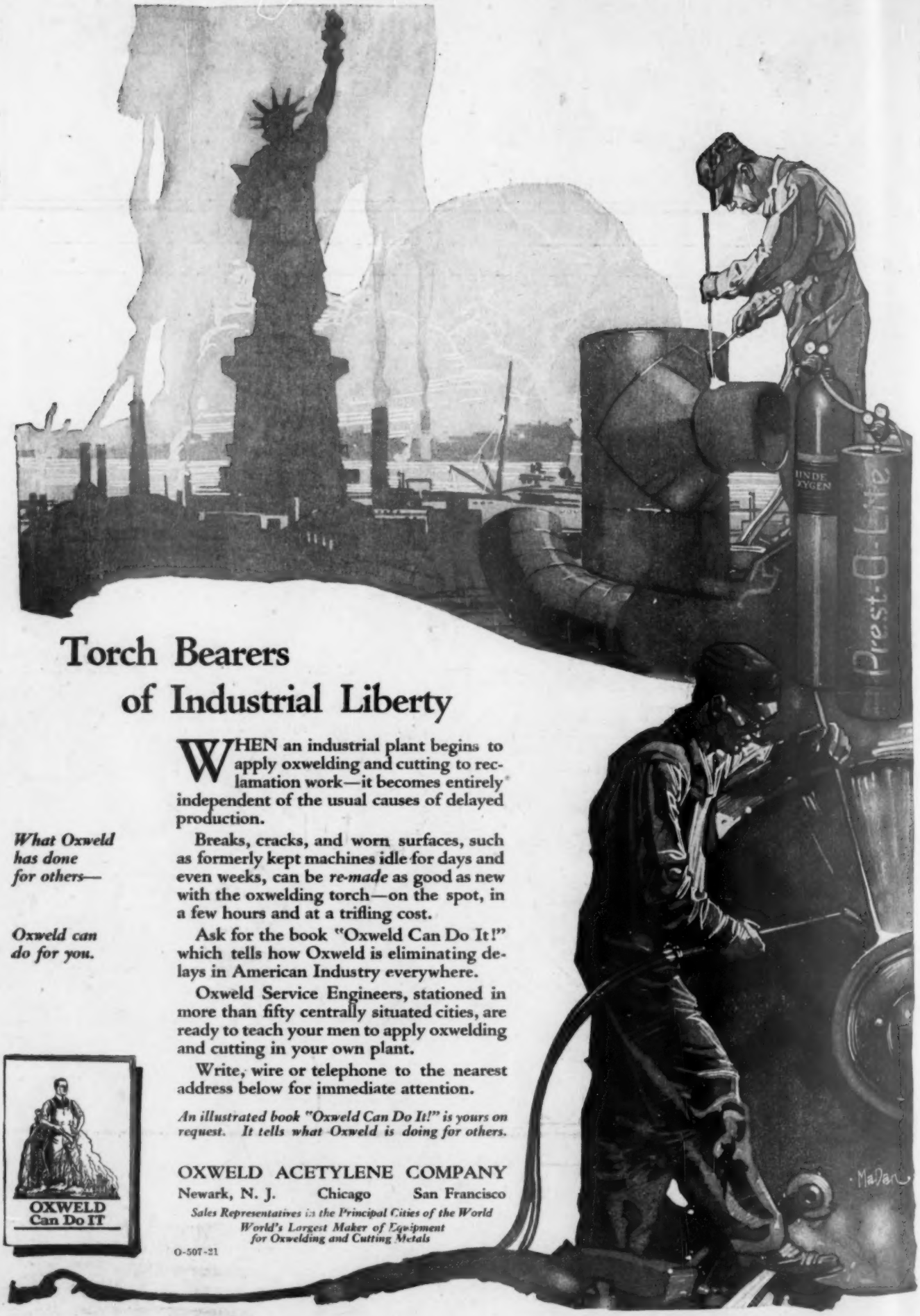

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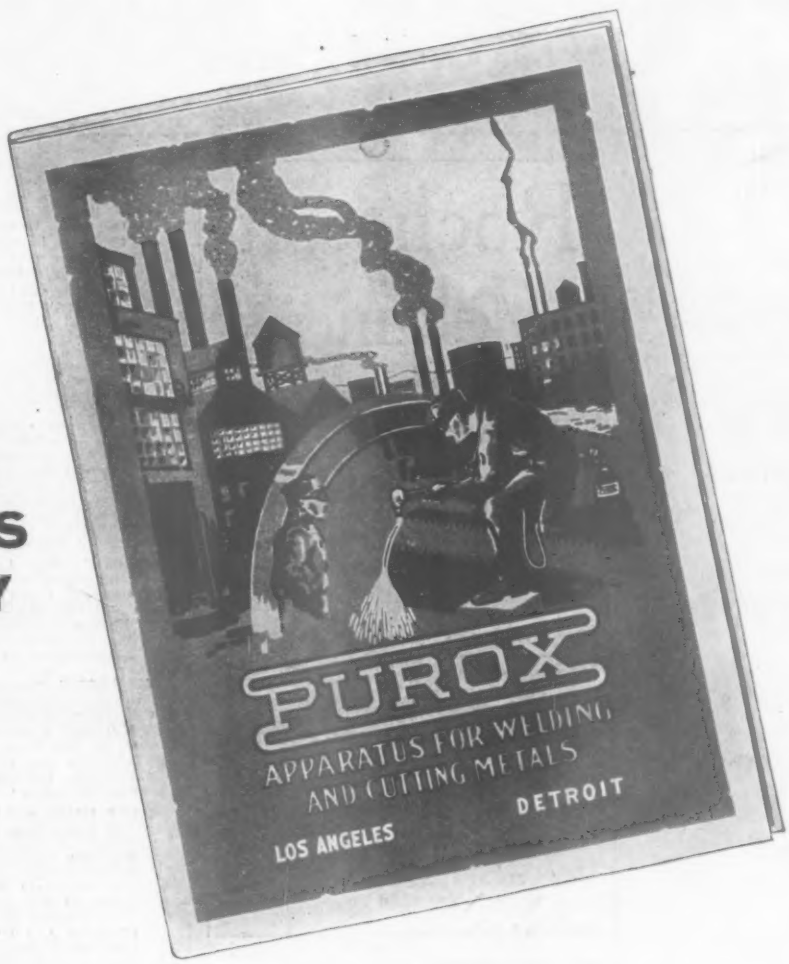

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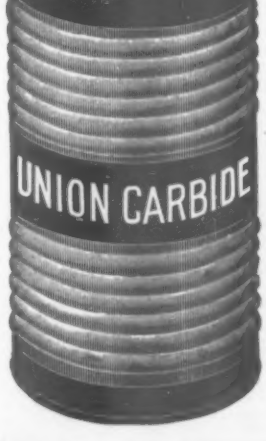

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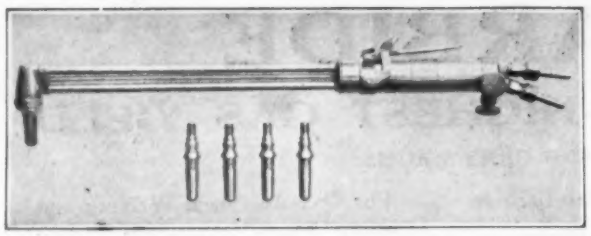

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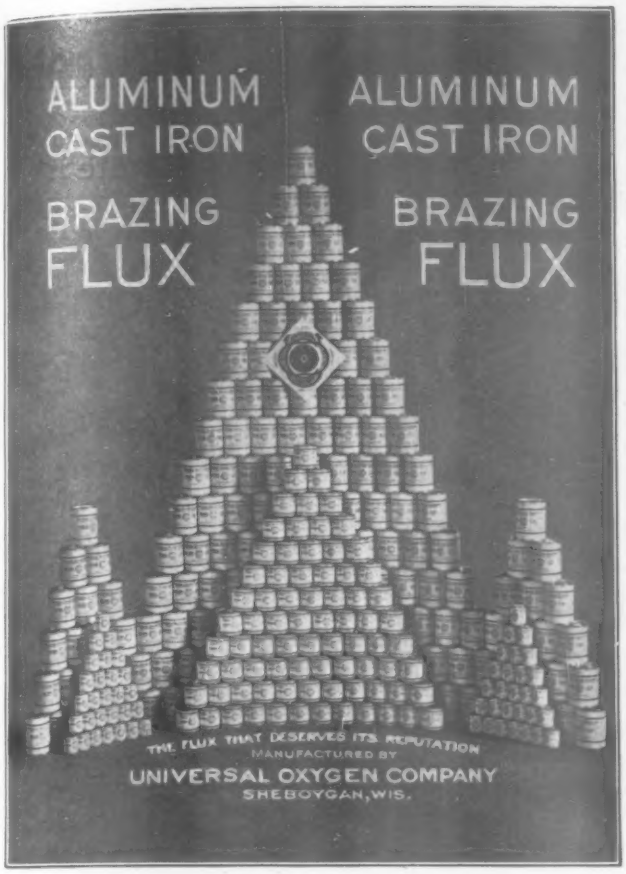

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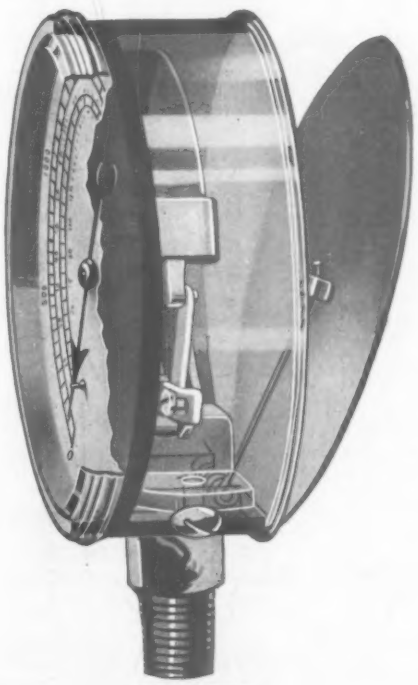

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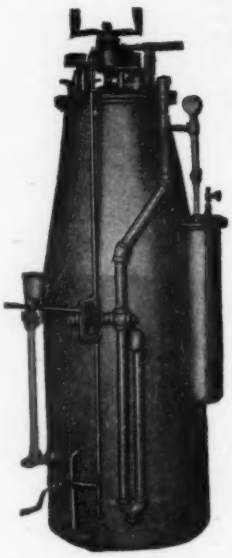

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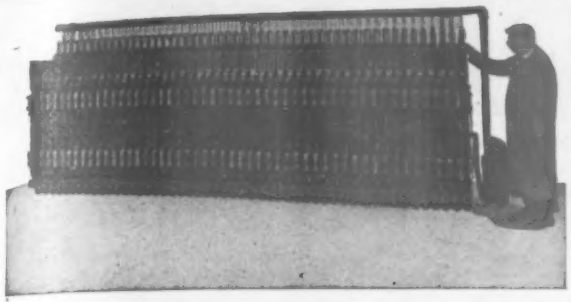

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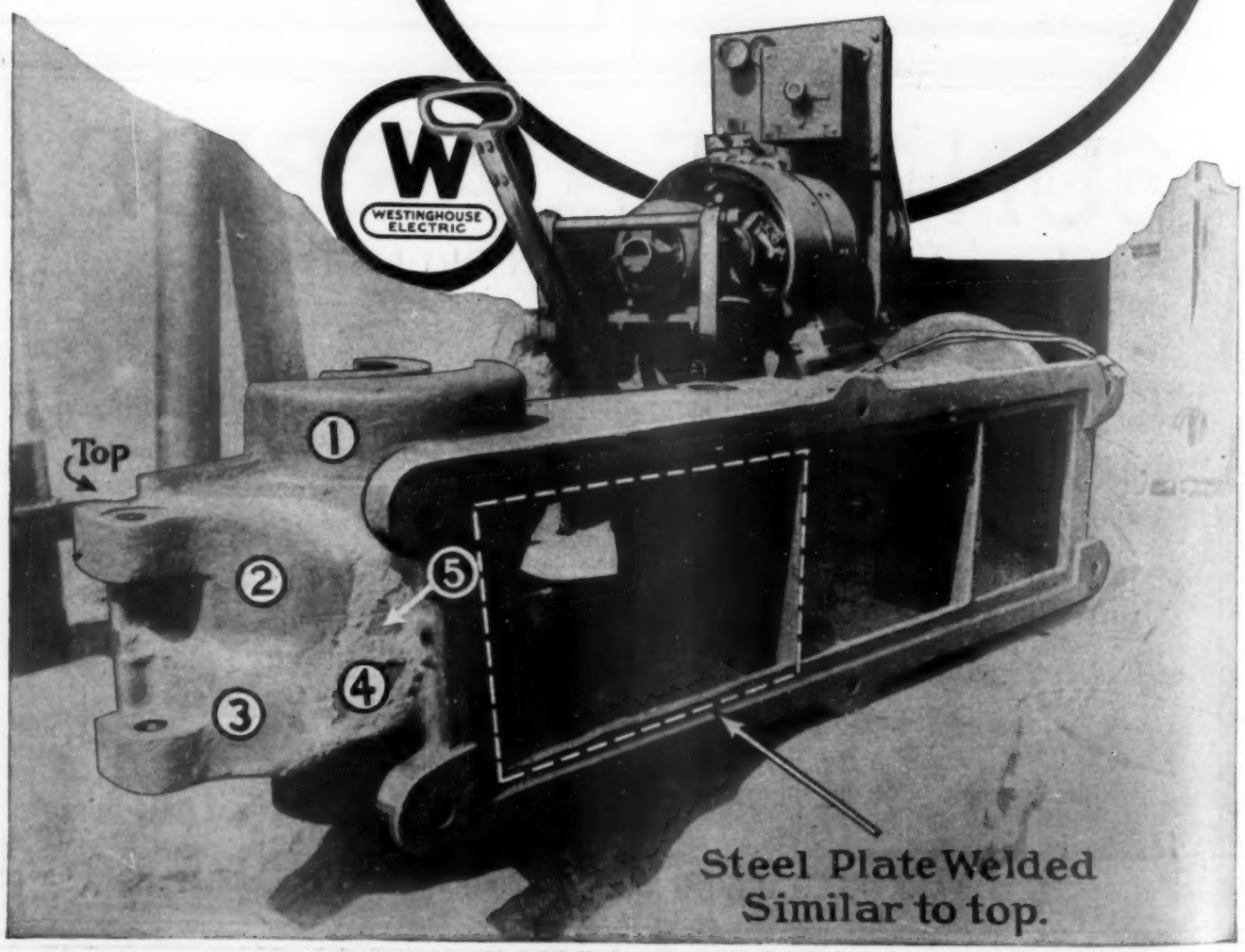

LIGHT travels at the rate of 186,000 miles per second, but it never reaches some people. For instance there's the man who doesn't know the difference between the cutting efficiency of 99% pure Oxygen and Oxygen of lower purity.

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Another Test Shows Lincoln Welder Best

Make of Welder	Average Welding Time Per Piece	Current Used Per Lb. of Metal Melted	Quality of Weld (Test Piece)
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Welder "B"	24 min. 20 sec.	2.4 KWH	Fractures good and clean; poor penetration
Welder "D"	19 min. 48 sec.	4.8 KWH	Fractures porous, fair; poor penetration
Welded "A"	17 min. 33 sec.	2.5 KWH	Fractures porous and dirty, poor penetration
LINCOLN	15 MIN. 4 SEC.	1.46 KWH	FRACTURES CLEAN AND GOOD; GOOD PENETRATION

The above tabulation is the result of an elaborate shop test made by a large automobile parts manufacturer to determine what welders they should buy.

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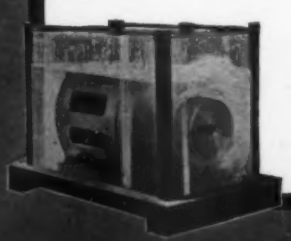
"Link Up with Lincoln"

This Standard Lincoln Motor operated over 3 years under water without damage.



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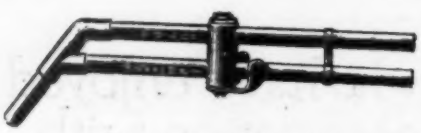

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Use of—Welding Knowledge—Puddle System—Flux System—Comparison of Systems—Welding Rod—Preparation of the Weld—Inlet Manifold—Arm of Crank Case—Welding the Arm Without Taking Out the Motor—Break in the Body of Case—Welding Cold—Wrong Method of Setting Up—Lug or Boss Welding—Preheating the Case—Gas Preheating Flame—One Side or Both—Collapse of Weld—Broken Bearings—Direction of Welding—Shrinkage Cracks—Missing Parts—Finishing—Die Moulded Castings—Body—Other Parts.

CHAPTER V.—STEEL.
Welding Knowledge—What the Flame Does to Steel—The Welding Rod—Simple Welding—Position of Flame—Reinforcing the Weld—Frame Welding—Lengthening the Chassis—Tube Housings—Worn Parts—Gear Welding — Case Hardening — Light Metal Welding—Gasoline Tank—Welding Adjacent to Rivets—Shaft Welding—Construction of Parts.

CHAPTER VI.—MALLEABLE IRON, COPPER, BRASS, BRONZE.
How to Detect Malleable Iron—Brazing Malleable Iron—Rear Housing—Reinforcing the Braze—Brazing Tube to Housing—Building Up Worn Parts—Copper—Brass and Bronze—Silver Soldering.

CHAPTER VII.—CARBON BURNING AND OTHER USES OF OXYGEN AND ACETYLENE.
Principle of Carbon Burning—Method of Operation—Lead Burning—Soldering—Case Hardening—Heating Uses.

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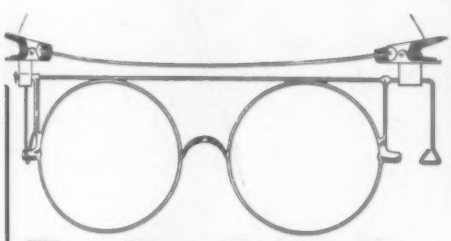

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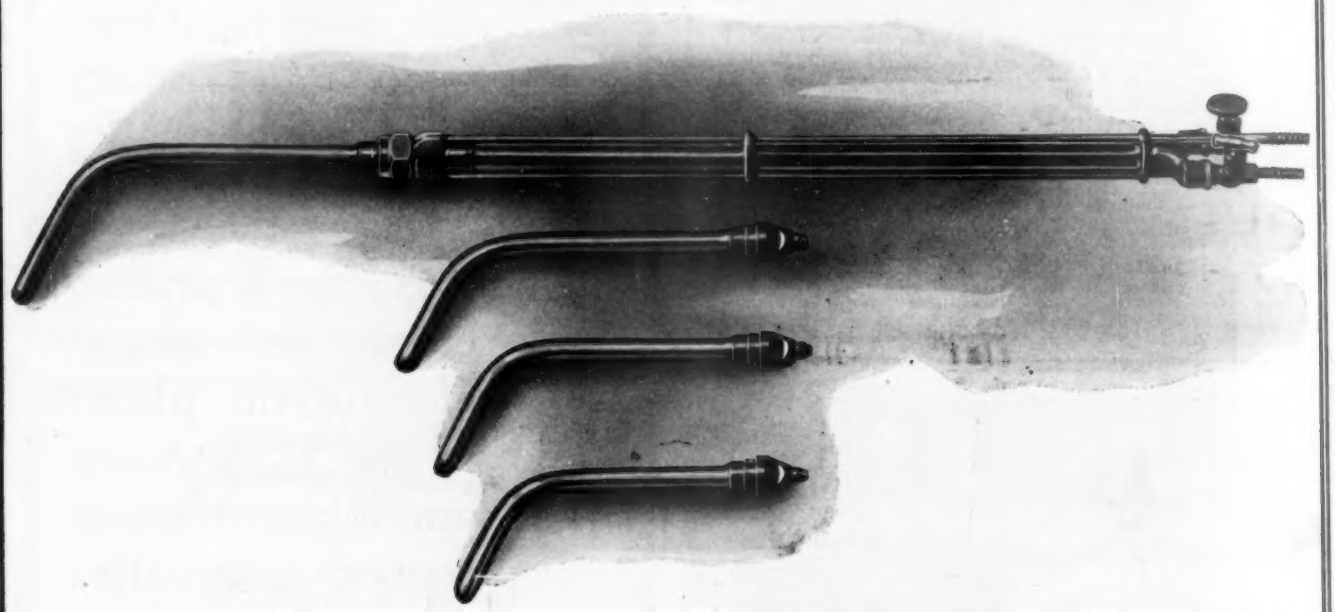

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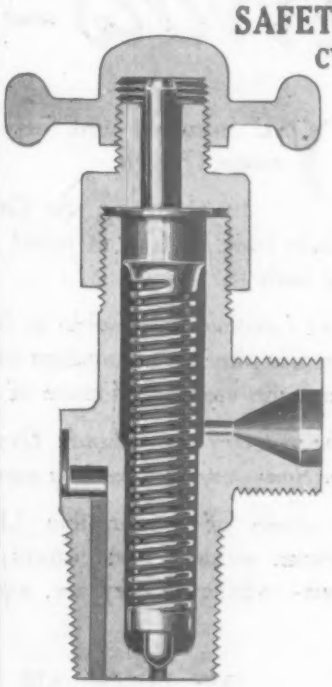

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PROGRESS AND NEEDS OF WELDING RESEARCH AND STANDARDIZATION

William Spraragen*

THE American Bureau of Welding was reorganized on November 22, 1920, as a joint advisory board of the American Welding Society and the Engineering Division of the National Research Council on welding research and standardization. The advisory board consists of representatives appointed by the American Welding Society, other interested scientific and engineering societites and organization, classification societies, government bureau and certain members at large appointed because of their special ability in matters pertaining to welding research and standardization. Full details of the new organization and its connection with the National Research Council were given in the October issue of the *Welding Engineer*.

At this reorganization meeting by-laws were adopted and the following officers elected:

Professor C. A. Adams, director; Mr. H. M. Hobart, first vice-director; Professor A. S. Kinsey, 2nd vice-director; Mr. Wm. Spraragen, secretary.

Although the need and importance of the bureau is recognized universally, a brief review of the situation is permissible.

Review of the Events Leading Up to the Formation of the Bureau

Welding is now recognized as one of the greatest aids in the construction and repair of metal structures. Its field of application is almost universal in extent. Although both the electric and oxy-acetylene processes of welding have been known and used in repair work in the railroad shops and other places for a number of years, it was up to a few years ago—essentially an art, dependent entirely upon the skill of the operator. It is true that there existed a considerable number of so-called experts of welding who had been using the process extensively in a practical way. Their success was the result of years of experience in making welds that seemed good enough for service.

Under the pressure of war it became necessary to reduce this art to a more scientific basis. It was therefore planned to sift the knowledge of these experts of welding in order to establish some fundamental conclusions upon which welding engineering could be started. However, all attempts of this nature failed, as not in a single instance could there be found a sufficient number of men whose opinions would justify one conclusion over another, in fact, almost exactly the opposite. An appeal to the manufacturers of apparatus resulted in the exposure of the same condition of affairs, namely, that there existed no reliable data on any important phase of the subject of welding.

It was evident that it was necessary to obtain a great number of actual test results in order to reduce this hopeless mass of conflicting opinions to a sound basis from which further progress could be made.

Accordingly a welding committee was organized in the fall of 1917 under the chairmanship of C. A. Adams, as a subcommittee of the general Engineering Committee of the National Council of Defense and later adopted as the Welding Committee of the Emergency Fleet Corporation. To deal with the more specific problems relating to research the Welding Committee appointed a Welding Research Sub-Committee under the chairmanship of Mr. H. M. Hobart. At one time this Research Committee had active sub-committees on Non-Destructive Methods of Examining Welds, Standard Procedure for Testing Welding Electrodes, Standard Procedure for Testing Welds and Welded Constructions, Metal Arc Welding, Gas Welding, Thermit Welding, Carbon Arc Welding, Spot Welding, Specifications for Welding Ship Hulls, Tank Welding, Reconnaissance Research, Metallurgical Aspects of Welding, Arc Investigations, Corrosion, Protection of Operators, Training of Operators, Carbon Arc Cutting and Gas Cutting.

Through the efforts of the Welding Committee, welding and its possibilities were brought before the attention of the entire country and received a stimulus which advanced its progress in three years to an extent which would normally have taken four or five times as long. A complete summary of the results accomplished by the Welding Committee would be beyond the scope of this report. Suffice to say that their investigations touched on nearly every phase of the welding situation. Welding is now rapidly extending its way to fields where it was thought it had no application before.

It is interesting to note that as a result of the efforts of the Welding Committee and its successor some forty papers have appeared on the subject of welding. In addition to these papers a large number of lectures have been delivered by members of the committee in various parts of the country.

At the conclusion of the war following the withdrawal of the financial support of the Fleet Corporation, the American Welding Society, organized mainly by members of the Welding Committee, invited delegates from leading scientific societies and departments of the government to form a permanent organization for welding research and standardization. This body was called the American Bureau of Welding and was closely affiliated with the American Welding Society and the Engineering Division of the National Research Council. In the latter case the research committees of the bureau were

*Secretary, *American Bureau of Welding.*

formally recognized as the research committees of the Engineering Division.

The need for further research is well recognized by those who are thoroughly familiar with welding and all its variables. This need led the bureau at the reorganization meeting to create the following ten research committees:

Electric Arc Welding.
Gas Welding.
Thermit Welding.
Resistance Welding.
Welding Conference.
Training of Operators.
Welding of Storage Tanks.
Welding Wire Specifications.
Standard Tests for Welds.
Specifications for Steel to be Welded.

The problem and value of the work to the industry of each of these committees is given herewith:

Electric Arc Welding

H. M. Hobart, Chairman

It has been pointed out by conservative experts that although excellent arc welding is being done on a wide scale, there is a margin of improvement over the present average quality, which, so far as it can be assessed from the result of physical tests, would amount to at least twenty-five per percent. A brief outline of some of the fundamental problems that must be solved by research work to bring about such an improvement is given herewith.

As a result of the WIRT-JONES (one of the many series of tests started under the Welding Research Committee) and other tests, it is now conceded that the proper current is one of the most important variables that enter into the making of a successful weld. Indeed, some of the difficulties encountered in properly welding plates thicker than a half-inch have been attributed to the use of improper current. It is therefore necessary to obtain enough test data to determine the proper current to use with the various sizes of electrodes for different thickness of plates.

In the preparation of welding edges the British practice a year ago permitted the use of a smaller angle of opening when the edges of the plates are veed, than accorded with American traditions. An investigation was conducted under the Welding Research Committee to determine the effect of the angle of opening on the strength of the weld. In this particular set of tests one-half inch ship plate was used with total openings of 30, 60, 90 and 120 degrees. The distance between the edges of the plate was one-eighth of an inch and the welding was done in a flat position. The results of tensile bending and elongation tests indicated that the wider openings of 90 and 120 degrees was a positive disadvantage, particularly if the saving in time and electrode material was taken into account. This saving in time and electrode material amounts to abount 40 to 50 per cent. Of course, one could have too small an opening in that the operator would not have sufficient room in which to manipulate his electrode. This point seems to have been reached when the total opening was 30 degrees. One would therefore conclude that the British practice of 60 degrees is the most economical bevel to use for one-half inch plate. Obviously a great deal of further research is needed to substantiate the above results and to extend the work to include different thicknesses of plates. There is also basis for belief that a shoulder in place of the heretofore commonly used sharp bottom edge of the bevel will constitute a material gain, not only in the saving of welding material, but also in the quality of the weld.

There has been considerable discussion in several research meetings as to the relative efficiencies of some six or eight different types of joint that are now in use. Indeed it has been pointed out that an increase in efficiency of at least fifty per cent could be gained by using a special style of joint in butt-welding half inch plates. This gain in efficiency would be produced by a particular style of preparation of the edges and not by any reinforcing. It therefore appears that this too would be a fruitful field for research.

Another important problem that remains to be solved is the proper number of layers and current to use for various thicknesses of plate and positions of welding. It would take several pages to go into the discussion of this point alone. Some experts will claim that by depositing the metal in one layer a weld will be made that will be free from initial stresses and that welds in more than one layer are not free from these stresses in that after the first layer has contracted, the cooling of the hot metal of any subsequent layers must produce strains which are included in the weld. On the other hand, the greater number of layers facilitates inspection and seemingly tends to give greater uniformity of work; for if a bad spot has developed in the first layer it is generally remedied by welding a good layer on top of it.

It might also be mentioned that excellent welding is being done on half inch material and even heavier plates with no preparation of the edges at all. The plates are lined up with a slight opening between them and by using two welders simultaneously, one on each side of the weld, there is no difficulty in obtaining perfect fusion.

The desirability of research is not ended with the solution of these fundamental problems. It is also important to solve the problem of extending the use of welding where it will be required to undergo severe service tests before it is universally adopted, particularly where the failure of a weld may result in the loss of life, such as in pressure vessels or ship construction.

The problem in these fields and those of an allied nature even where the failure of a weld would not be apt to cause any loss of life or serious damage, such as the construction of tanks for holding water, oil and gas, reduces itself to the fundamental problem of properly welding a long seam. Everyone knows that the successful welding of a long seam is entirely different from making a weld of short length. Due to the continued contraction of the cooling metal as the weld progresses and the rigidness of the finished portion, stresses of an unknown magnitude are introduced in the weld. These stresses may either distort the plate or be great enough to crack the plate after the weld is finished or shortly after it is put into service. Some specialists say that these stresses are greatly increased by the use of the so-called rigid method of welding. Others contend that these stresses can be largely overcome by introducing novel features of welding such as dividing the length to be welded in say six equal portions, and then welding the first portion, shipping the next, welding the third, etc. Another plan is to start the weld at the center of the seam and weld toward each end. In fact all sorts of combinations have been proposed. These problems incidentally involve the style of joint and the current and number of layers that are to be used. With the exception of a few isolated cases little or no progress has been made in the solution of this important phase of welding.

There are also several other lines for research which at present are of a more academic value and which in time may become of great economic importance. Chief among these is the investigation of the arc. This investigation is a difficult problem. So many phenomena occur in a small space and the difficulty of determining the precise conditions under which each of the various phenomena is most effective tends to increase the troubles in finding a solution which will be satisfactory. At present the several theories that have been advanced to account for the transference of the metal across the arc are by vapor stream, by gaseous expulsion, by fine spray, by liquid drops and by surface tension. The general trend of conclusions seems to point to a combination of theories as the solution but that the vapor theory accounts for the transference of the greatest portion of the metal.

Gas Welding

S. W. Miller, Chairman

The necessity for research work on the fundamentals of gas welding is as important as it is in the electrical field. Indeed the problem in many respects are quite similar.

The proper angle of bevel and design of joint for various thicknesses of plate is a fundamental problem of research in gas welding both from the viewpoint of the strength of the resulting weld and the economies which may result by the proper design of joint.

Although the best method of adding welding material for plate of various thicknesses has been a subject of discussion among experts during the past few years, no definite conclusions have been reached in the matter. For instance, some experts maintain that the weld should be made by depositing metal and building up to full thickness as quickly as possible, with a steep slope for the molten metal. Others maintain that while the metal should be deposited in a single layer the slope should be much more gradual. Still others argue that the weld should be made in layers by stage or progressive method with the length of each layer equal to about four times the thickness of the plate.

In connection with the proper method of laying down the metal the method of holding the torch promises to be an important factor, that is, whether the blowpipe flame should play away or toward the molten metal.

In addition to the fundamentals mentioned above the proper method of welding satisfactorily a long seam by the oxy-acetylene process offers as many difficulties as it does in the case of electric welding although the solution will undoubtedly be different. For instance, it would probably be inadvisable from an economic standpoint to use a step-back system (unless a very simple one) to prevent distortion or locked-up stresses. This is easily recognized when we consider that a certain amount of time and gas is needed to heat up the work to the required temperature necessary for welding.

Some other problems of research are advantages of various welding wires for different kinds of welds (to be handled in conjunction or by Welding Wire Specifications Committee); pressure and purity of gases; speed of welding; and correct size of tip to use for various kinds of work.

Welding Conference Committee

A. S. Kinsey, Chairman

This committee was organized at the request of the Council of the A. S. M. E. to confer with their Boiler Code Committee in drawing up regulations regarding the use of welding in the construction of pressure vessels.

Problem. The proposed regulation of the Boiler Code Committee places some severe restrictions on the use of welding for unfired pressure vessels. Through the joint efforts of the Boiler Code Committee and the Bureau of Welding, subcommittees, specifications will be drawn up in regard to the use of welding in the manufacture of pressure vessels which will have the proper requisites for safety without placing unjust restriction on the uses of welding in such constructions.

Program. (a) The committee through the aid of questionnaires has obtained a large amount of detailed information on all of the elements which have entered into the successful welding of pressure vessels in the past. This information was instrumental in convincing the Welding Committee of the A. S. M. E. of the undisputed possibilities of welding in connection with the construction of pressure vessels.

(b) Through a series of test samples which are being welded both by the gas and electric processes at a number of places the committee hopes to demonstrate the feasibility of using welding under proper procedure in the construction of pressure vessels with entire safety, beyond the restriction now placed on such use by the Boiler Code Committee. These investigations will be extended to destructive tests of full size vessels.

(c) This committee will also assist the Boiler Code Committee in its final specifications for the construction of pressure vessels in so far as it relates to welding. Indeed, plans are now under way for drawing up this code.

Welding of Storage Tanks

J. C. Lincoln, Chairman

This committee was organized to meet the requests for information from the Standard Oil Company as to the proper procedure for welding storage tanks for holding light oils. Considerable difficulty has been experienced in the riveted tank because such structures in practice do not prove to be "oil tight" for the lighter oils.

This present plan is to draw up proper specifications for the construction by electric welding by a 40' diam. tank. This is one of the common size tanks that are being constructed by the Standard Oil Company by riveting and this company has agreed to construct one of these tanks by the use of welding.

Progress Report. Under date of December 8, 1920, Mr. Lincoln reports that a print and specifications showing a proposed method of arc welding an oil storage tank 93 ft. diameter, 35 ft. high has been prepared. These were sent to the members of the committe for criticism and at a committee meeting held on the 22nd of November, some changes were adopted and suggestions made as to improving the proposed method. Further, sub-committees for doing this work by oxy-acetylene and by resistance welding were appointed. It is expected that another meeting of the committee early in the year will enable it to make some definite recommendations.

The work of this committee will be of tremendous value in demonstrating the feasibility of replacing riveted storage tanks by welding, with a resulting economy of cost and increase in quality at least as far as the tightness of seam is concerned. Incidentally, it will open up a new field for welding and a field for which it is particularly adapted.

Welding Wire Specifications Committee

C. A. McCune, Chairman.

During the greater part of the past year this committee has been actively engaged in collecting data as to the chemical analysis of welding wire used for both gas and electric welding, in the railroads, shipyards and other places and the service results obtained from the use of such wire. From this data the committee expects to obtain sufficient information to enable them to draw up specifications as to the proper limits of the chemical content of welding wire to be used for different purposes.

Specifications have already been completed for wire to be used in welding mild steel and will be extended to include the welding of high carbon, alloy steel and non-ferrous metals. It is expected to issue the completed information in folio form.

The subject of electrodes also offers promising fields for investigation. A chemical analysis of the deposited metal for a great variety of electrodes reveals the fact that the greatest proportion of the metal additions and impurities are burnt out in traversing the arc, leaving a much more uniform deposit from the viewpoint of a chemical anlysis than the wide variation of the chemical composition of the different types of electrodes used, would lead one to expect. A good electrode may be roughly picked out by observing its workability and penetration of the deposited metal under the same current and voltage conditions. It has also been discovered that so called bad electrodes may be made good by dipping in lime water. On the other hand a good electrode may be made unfit for welding purposes by simply removing the thin scale of the outer surface with the aid of an emery cloth. No feasible explanation has yet been advanced for this latter phenomena.

There are some eminent experts and metallurgists who will claim that the method of manufacture has more to do in determining whether an electrode is good or bad than chemical

composition. They argue that welding electrodes of identical chemical analysis give very different results in service. Likewise electrodes of greatly different chemical analysis give equally good results in service. Some have ventured the opinion that the variation in the lubricants used on the dies through which the electrode wire is drawn vary in composition and may have some influence on the resulting material.

It should be pointed out that some of the most serious drawbacks to the investigation of electrodes has been the problem of the personal equation involved in the operator. Very often greater variations have been produced in results by the use of two different operators, although both skilled, than by all the other variables put together. With the development of the automatic machine, giving an exactness of operation which compares favorably with the lathe, further progress may be made, although such investivations would for the present necessarily be confined to the use of direct current and bare wire electrodes.

Similar problems are encountered in welding rods to be used for gas welding. In fact, variations in chemical composition promises to be a more important factor than in electrodes for metal arc welding. While chemical composition undoubtedly has its effect on penetration and workability in electric arc welding, yet wide variations of the strength of an electric weld cannot be from our present knowledge attributed to chemical composition alone. On the other hand, a number of experts are of the opinion that the chemical composition of a gas welding rod has a decided influence on the strength and ductility of the resulting gas weld.

Standard Tests for Welds

F. M. Farmer, Chairman.

Early in its career, the Welding Committee noted that in some cases the wide differences of opinion that existed relative to welding matters were the results of mechanical tests. However, an examination of the test data disclosed a wide variation in the character of the tests made, and the details of procedure, so that it was not only difficult to analyze and check the basis of the conclusions, but practically impossible to correlate various groups of test results.

The chief difference between testing a specimen of steel that includes a welded joint and testing an ordinary specimen is the non-homogeneity of the welded specimen. The welded specimen has at its center a section composed of material that usually has physical, chemical and metallurigcal characteristics distinctly different from the adjoining metal. Furthermore, the section of the added metal is more or less irregular in shape and variable in size. Consequently the procedure prescribed for testing of ordinary specimens is not applicable to specimens containing welded joints.

A good example of the difference of the testing technique that must be employed can be seen in the case of the cold bend test. The usual specifications require that the specimen be bent around a pin of prescribed diameter through an angle of 180 degrees without cracking—the manner in which the load is applied is therefore immaterial. Due to its lower ductility the specimen containing a welded joint will not bend through 180 degrees without cracking. It is therefore obvious that in the latter case, the farther apart the supports are, the greater will be the angle of bend before any crack develops, simply because the welded joint being the stiffer, most of the bending takes place in the original metal. It is therefore necessary that a standard test be prescribed that exactly fixes the distance between the supports, the curvature of the surface of the supports, and the manner of applying the load for different thicknesses of specimens.

In this particular test the Welding Committee evolved with the aid of the Electrical Testing Laboratories and the Bureau of Standards a specification which tests the specimens as a simple beam with the load applied to the center of the weld and midway between the supports. In order to force most of the bending to take place in the weld, the supporting surfaces are placed as closely together as practicable, so that the deposited metal will occupy the greatest portion of the beam. The minimum distance for each thickness of test specimen is obviously determined by the space that is necessary to allow the specimen to bend through 180 degrees.

Full details giving the exact specifications adopted for all tests on welded specimens are now under consideration by this committee and will, no doubt, be soon ready for distribution.

Considerable work has also been done in the development of non-destructive methods of testing welded joints. The requirements of a satisfactory non-destructive test are, that in addition to detecting a bad weld, it must not injure it in any way if it is good.

Some of the schemes that have been tried along this direction are X-Ray tests and variations of electric and magnetic conductivity tests. The X-Ray test was abandoned as being expensive and therefore impracticable from a commercial standpoint. The other two methods have been tried with a fair degree of success and further results are awaited with interest. However, some of the more simple and widely adopted tests are various oil penetration and air pressure tests or combinations of both. One tank manufacturer who is successfully using welding, employs a combination of air and impact tests. That is, the tank is operated under a definite pressure and a blow or blows of definite force are delivered to the weld while the tank is subjected to this pressure. This scheme promises to be the most feasible for this class of work. However, a great deal of standardization of methods is needed in all such tests.

Training of Welding Operators

W. Spraragen, Chairman

The importance of the training of operators for both gas and electric welding cannot be overestimated. A very large number of welding experts regard it by far as the *most important problem.* Widely different ideas as to the proper procedure to follow in the training of welding operators prevail even among experts. For instance, the time required for the correct training of an operator, as stated by a number of authorities, varies from three weeks to two years. Nor is there any greater agreement of the opinions as to what the training should include. Some say that the rudiments of a technical education is necessary, while others stoutly maintain that the operator should only be trained in the correct manipulation of the electrode or torch. In nearly every case where welding has been condemned or where severe legislation has been enacted to restrict its use, the case can be traced directly to poor welds made by unqualified operators.

A questionnaire has been sent out to a number of welding schools, railroads, shipyards and manufacturing plants asking for detailed information relative to the methods used by them in the training of operators. This data will be used in compiling a bulletin.

Some of the elements that will be considered in this bulletin will be welding opportunities; prerequisites for welding operators; general descriptions of methods of training, duration of course, equipment, protection of operators, and nomenclature; elementary information on gas and electric welding; set of simple lessons, and short bibliography.

Specifications for Steel to Be Welded

W. J. Beck Chairman

It is now a recognized fact that the chemical composition of the parent metal has a decided bearing on the quality of the resulting weld. Much thought has been given lately to the necessity for having specifications of steel to be used for welding purposes. Different chemical composition (notably carbon content) will undoubtedly require different welding procedure. For instance, several authorities maintain that

plates having a carbon content of over 0.35 carbon should not be welded where strength of the weld is an important factor.

The fact that carbon content increases considerably with the thickness of the plates may partly account for the difficulty formerly encountered in welding plates of one inch thickness or over.

In this connection Commander S. V. Goodall in a paper read before a meeting of the American Institute of Electrical Engineers in February, 1919, states, "It appears to be the fact that shipbuilding steel in Great Britain is more adapted to welding than shipbuilding steel in this country and the former is also more regular in its qualities." Several welding experts have gone on record in stating that the "quality" of steel (other than its chemical composition) has an important bearing on its weldability.

The uniformity of plates as to chemical composition is also a subject which merits attention. Other important varieties are phosphorous, sulphur and manganese content.

The work of this committee will be carried on in close conjunction with the work of the other welding research committees.

Resistance Welding

H. Lemp, Chairman

Although this is one of the oldest and most reliable processes of welding, there are a number of fundamental problems that still remain to be solved.

Very recently the limits formerly regarded as the maximum thickness at which plates could be satisfactorily welded by the "seam method" have been surpassed. The same progress has been made in the extension of the use of spot welding. New applications are coming up which require fundamental scientific knowledge of the variables that enter in the successful execution of a resistance weld. Some of these variables are time, current, pressure, methods of clamping (particularly where parts to be welded have different specific heats and melting points). Research work is also needed in the development of the machines themselves.

A new type of percussive welding machine has been developed which promises unusual possibilities for butt welding stock up to ¾ inches in diameter.

Thermit Welding

J. H. Deppeler, Chairman

The efforts of this committee will be confined largely to answering the technical problems that come up in this field. Research work is being carried on continually by the Metal & Thermit Corporation.

Conclusions—Present Status and Needs

The need for further research work is quite apparent to those who are thoroughly familiar with welding and all its variables.

To get a good start on the solution of the fundamentals of electric and gas welding some $20,000 would be necessary. Moreover, to extend such investigations to the welding of long seams and actual structures would require an even larger sum.

The entire industry is beginning to realize that before the proper confidence in welding can be established, particularly in fields where strength is necessary, it must satisfactorily demonstrate its worthiness and dependability. The problem of proper welding procedure and training of operators necessary to obtain uniformly consistent sound welds must be solved before such extension and use of welding can take place. To wait for the ordinary evolution of the art would take many years, with a resulting loss of millions of dollars to the nation and world.

The regular monthly meeting of the American Welding Society, Chicago Section, will be held Friday evening, March 25, 7:30 P. M., Room 1736 Monadnock Building.

INTRICATE WELDING REPAIR HANDLED WITH GREAT SKILL

In Fig. 1—the motor base, crank case and gear case of a Mack truck are shown in eighteen separate pieces—about as complete a smash-up as one could wish to see. To reassemble this pot pourri of broken parts and weld them into their original form is an undertaking to tax the ingenuity and skill of the best of welders. To begin with a special set of jigs

Figure 1. An Unusually Complex Problem.

had to be devised, and during the welding far greater care was necessary to prevent distortion than would have been the case, for instance, were the parts of cast iron or steel.

Aluminum has a very low melting point (only 1,215 degrees F.), has a relatively high co-officient of expansion, and a short fusing range. At a temperature just below fusing it becomes

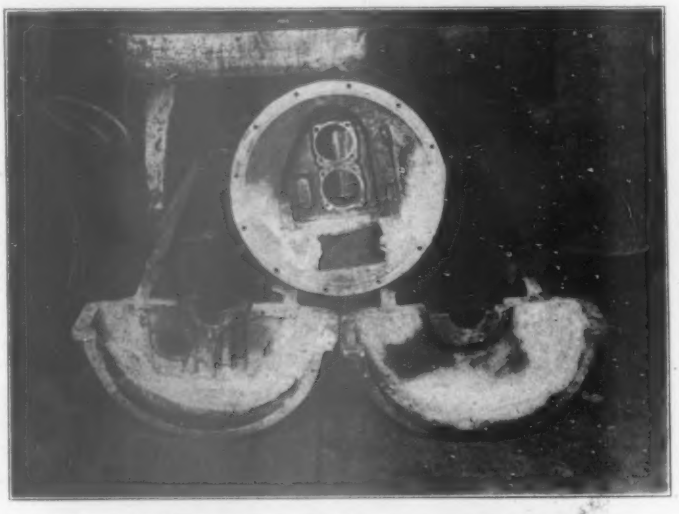


Fig. 2. Skill with the Torch Has Overcome All Difficulties.

plastic and the parts have to be firmly held in place and supported. In a state of fusion the metal is very fluid and has a troublesome affinity for gases, especially atmospheric oxygen, which forms a refractory oxide that the welder must deftly remove or seriously impair the weld. Then there is the slow process of cooling necessary to anneal the jointures.

Fig. 2 shows the repair in its completed form ready to be replaced and restored to service. This is one of the most involved and interesting aluminum casting repairs that has been noted in recent months. The work was done with the torch, of course, and it is suggestive of the great ability of the oxy-acetylene process in the automotive repair field.

WELDING PRESSURE VESSELS*

By Andrew Oliver†

ONE of the most important projects of the American Welding Society is that of securing a better rating on the welding of pressure vessels by the Boiler Code Committee of the A. S. M. E. In the Standard Oil Company plant at Whiting, Indiana, we have experimented with autogenous welding of all sorts of pressure vessels. Some of the most

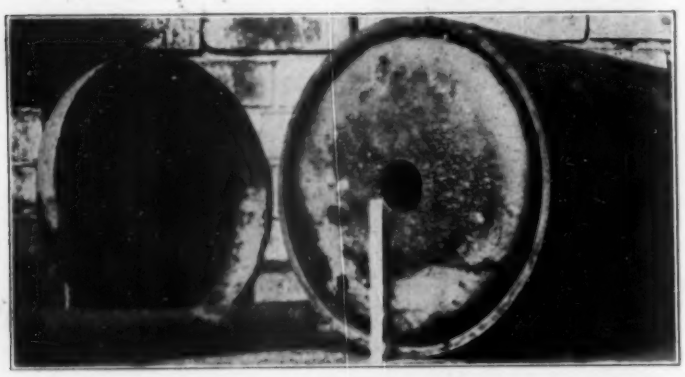


Figure 1. Note Size of Head.

important work that we have done is shown in the photographs here.

Figure 1 shows one of our tanks before welding. This is one of the first methods of preparing the work that we used. To the left of the tank is seen one of the ends already to be inserted. This flanged head was prepared in a manner similar to the standard boiler makers' practice. Then it was inverted and welded.

Figure 2 shows the result of this weld. Notice that the head is perfectly flat. The principal problem was to find a means of testing the strength of the tank. We had only one set of pumps with pressure enough to make a reasonable test. The tank was filled with hot oil and pressure was applied to

Figure 2. One of the First Welded Tanks.

500 pounds. The tank was then tested by hammering and showed no defect. The pressure was then increased to 1,000 pounds and a slight bulge was noticed. When the pressure was again increased to 1,500 pounds the tank bulged quite a bit more but did not break. Further attempts at increasing the pressure resulted in stalling our hydraulic pump at 1,800 pounds without any noticeable effect on the tank. Before releasing the pressure this tank was tested by stout blows with heavy sledge hammers and no leaks developed.

Since this first experiment many different types of pressure vessels have been welded in our shops. Figure 4 is a diagram of one that we make in great numbers. This tank has to stand a working pressure of 100 pounds to the square inch and is constantly subjected to a temperature of 750 degrees Fahr. The tank is 44 inches long and 20 inches in diameter and is made of one-half inch plate throughout. The diagram shows clearly the difference in construction of the head. This difference in construction lowers the cost of material and of preparation and this head stands as much pressure as the flanged head shown in the other illustrations. The heads are dished with a hammer and beveled with a torch. The side seam is beveled to a 45 degree angle with the torch before welding. When the oxy-acetylene process is used, the seam is welded both outside and inside. The head is inserted about half an inch below the edge of the cylinder. This gives the welder a better chance to get at the work in such a way as to make sure of thorough penetration. The method of operation is to weld three or four inches lightly, fill to the top, and so on, to the end of the seam or weld.

After welding these tanks are subjected to a pressure of 600 pounds per square inch with cold water and tested with a sledge. The first one of these to be constructed in this manner has been in daily use for four years, subjected to both heat and pressure and is still giving good service.

Figure 3. Result of 1800 lb. Pressure Test.

Another tank somewhat similar to this one is made of 15-inch extra heavy steel pipe, tested to 1,000 pounds per square inch and put in service under working pressure of 300 pounds. In service the heat has burned holes in these tanks, but no heads have blown out.

Our experience in pressure welding is not limited to these tanks. We keep ten or twelve locomotives in repair all the time and do a great deal of tube welding and we have had no failures of any consequence during the past six years. In the construction of stills we are now starting to increase the application of welding every week. Our former practice was to use a double row of rivets on these stills. In the future we plan to make a lap joint, insert a single row of rivets and then double weld them.

Question. In beveling these longitudinal seams, do you make a double "V"?

Answer. No. We make a double bevel: that is, one side only is beveled to an angle of 45 degrees on each side of the seam.

Q. What is the reason for welding on the inside?

A. The weld on the inside is simply a wash weld to make the joints smooth.

Q. Do you make the entire outside weld first, then come back and weld it again on the inside?

A. Yes.

†*Welding Superintendent, Standard Oil Co., Whiting, Ind.*

**Paper read before The American Welding Society (Chicago Section), February 25, 1921.*

Q. Doesn't this, in the case of the oxy-acetylene weld, have a tendency to set up a strain?

A. This has never been noticed.

Q. How do you allow for the expansion and contraction?

A. When the welding is started an opening of 5/8 inch for every foot of length of seam is left at the far end.

Q. How do you keep the crack open?

A. With a wedge.

Q. Will this spreading change the dimensions of the tank?

A. No, the weld contracts and closes the sheet to proper dimensions.

Q. Isn't it true that the greatest contraction occurs when the welder is working at the center of the seam?

A. Yes.

Q. Does the process (gas or electric) used make any difference in the amount of opening?

A. Yes, there is more radiation in gas welding, so, when using the electric arc process, not quite so much opening is required.

Q. Which process is used in making the tanks just described?

A. Both.

Q. How much reinforcement is made on the seam weld?

A. Just a trifle over the surface. The added metal is made to lap over about 1/8 inch on each side of the "V."

Q. Is it necessary to support the weld during the operation by placing a flat bar under the weld?

A. No.

Q. How many amperes do you use, and what size wire, when you make these welds with the arc?

A. Two hundred amperes of current. The first weld is made with 5/32 or 3/16 wire, then followed with a 1/4-inch wire.

Q. What is the usual speed when welding the head?

A. Four to seven feet per hour with heavy wire.

Q. Is any attempt made to clean the electric welds?

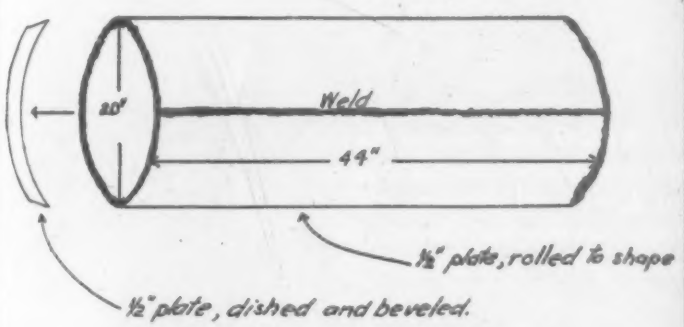


Figure 4. Present Method of Welding.

A. Not to any extent. Any drops that are left by the arc can be chipped off with a chisel.

Q. Do you test your *welders* before starting them on this work?

A. Yes. The foreman keeps a careful check on new men and makes sure they can do first-class work before giving them this kind of a job.

Remark: In connection with the discussion on the amount of opening to be provided before starting to weld, reference was made to the following extract from a paper, "Welding," read by Charles Hollup before the American Society of Refrigerating Engineers, Milwaukee, Wis., June 7, 1917.

Longitudinal Seams

In welding longitudinal seams on round tanks it is first necessary to have a perfectly round shell; that is, the joining ends of the sheet shall not have a flattened section, as customary when coming from the bending rolls. That flat and peaked-looking joint has a tendency of rounding out under pressure and, in so doing, has a wedging action on the weld, which is often the cause of rupture. The edges of the seam should be beveled as in all other butt welds.

Before proceeding to weld a seam of this kind, expansion and contraction must be considered. These are vital points in welding, and only too often lost sight of. Starting on one edge of the seam it is necessary to have the edges of the sheet on the far end spread apart. The object is to allow the molten metal, which is then at its most expanded state, to shrink and gradually bring the edges together as the weld is progressing, thereby avoiding shrinkage strains as much as possible. For the same reason I advocate that a seam of that kind should be made at one filling in if possible, or if the sheet is too thick that the heaviest fill be made while the other end is still open. The proper amount of this opening for acetylene welding should equal the thickness of the sheet per foot of length. In other words, a 1/4-inch thick sheet 6 feet long should be 6 x 1/4, or 1½ inches open on the far end. For electric arc welding about one-half of this is enough.

WELDING EXHIBIT INTERESTS

One of the exhibits at the recent motor show in Rochester, N. Y., which created more than a passing interest in the accessory department, was that of the General Welding Works of 87 Cortland street.

Joseph J. White, who for a number of years has been associated with the welding industry, and who is well known by all factory and automobile men in connection with this work, opened the General Welding Works a little over a year ago. The business which has been acquired since that time has far outreached all expectations.

The shop superintendent, C. R. Woleslagle, has, through national tests, proven himself one of the most perfect steel welders in the country and has unusual ability along the line of instructing his workmen in the use of the newest and best methods of welding all metals.

The company's exhibition showed an unusual display of welding aluminum crank cases, transmission cases, automobile

General Welding Works Booth at Motor Show.

frames, showing reinforcements, welded high pressure pipe, rear axle housings, scored cylinders, etc.

The scored cylinder display was one of their most interesting features and was of great benefit to all car owners and garages. The General Welding Works is a licensee of L. Lawrence & Co., who own the United States and foreign patents on the repair of scored cylinders and cracked water jackets by their special method.

Commenting on the results of this exhibit, Mr. White says:

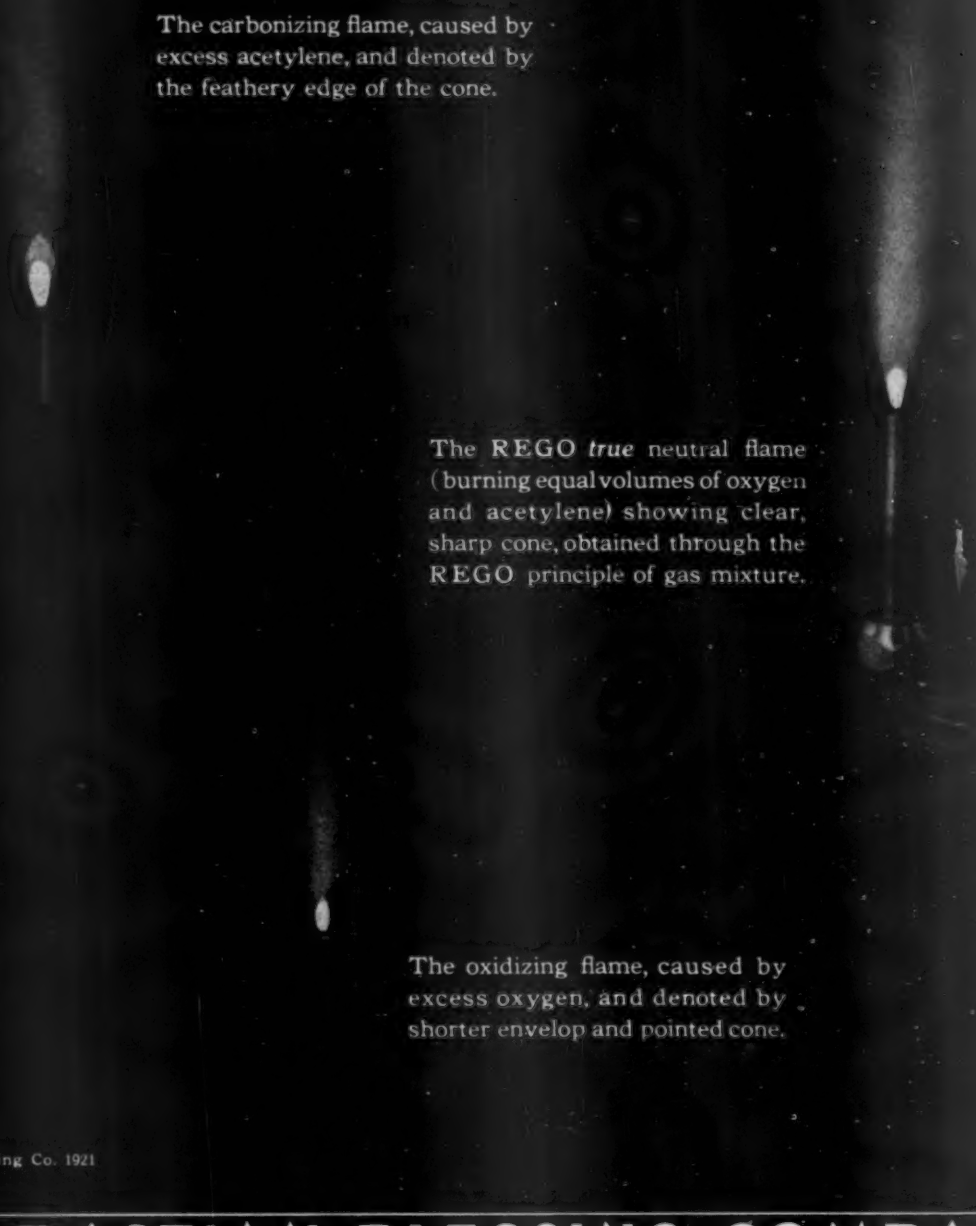
"If you should care to publish this, we might say for the benefit of your readers that we have found no medium of advertising which has been so beneficial and from which we could so easily trace concrete results. During the week that our display was being shown, besides securing countless automobile parts, such as cylinder blocks, crank cases, automobile frames, etc. (a large part of which came from surrounding towns), we obtained three large production jobs which did not pertain to automobile work in any way. Superintendents of large plants were able to see for themselves the quality of our work on various metals, and the manufacturing work secured will extend over a period of several months."

WELDING AND CUTTING APPARATUS

Welding Torch Flames

Produced by tips of the same size

Reproduced from actual photographs


The carbonizing flame, caused by excess acetylene, and denoted by the feathery edge of the cone.
The REGO *true* neutral flame (burning equal volumes of oxygen and acetylene) showing clear, sharp cone, obtained through the REGO principle of gas mixture.
The oxidizing flame, caused by excess oxygen, and denoted by shorter envelop and pointed cone.

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REPAIRING A DISABLED ROCK CRUSHER

WHILE a large primary crusher operating in Plant No. 2 of the Edward Balf Company's quarries, near Hartford, Conn., was recently engaged in crushing large pieces of trap rock, the chute into which the material falls from the bottom jaw opening became clogged. This clogging in turn choked up the jaw hopper with material. As the rock was fed into the crusher close to one side frame a severe strain was thrown on the frame at this point. It so happened that this side frame had previously been broken near this corner and the two parts had been afterwards held in place by clamping the two broken sections together. The strain caused by choking of the jaw with material bent the side frame outward where the parts were clamped. This bending in turn threw a terrific strain on the other side frame at the opposite rigid corner.

Figure 1. Thermit Weld Before Removing Pouring and Heating Gates.— Figure 2. Ramming the Mold Box.—Fig. 3. Ramming Molding Material By Hand Into Interior Pocket.

Something was due to break. The safety toggle of the pitman refused to break, with the result that the end of the side frame at the opposite corner from the clamps was sheared off entirely along the edge of the keyway where the rear head fits into it.

Nature of Fracture

The line of fracture ran somewhat diagonally down through the side frame, extending from about 3 in. from the end of the casting at the top to about 5 in. from the end at the bottom, the length of the fracture measuring somewhat over 3½ ft. The section at the break, the total width of which was 12 in., contained two shallow pockets surrounded by 3-in. thick walls, as shown in an illustration. (Fig. 7.)

Considerations Affecting a Repair

As the accident occurred during a very busy summer period the production of the company was very seriously curtailed. The normal producing capacity of about 1,000 tons of crushed rock per day was reduced to only around 450 to 500 tons, or a decrease of about 50 per cent.

While normally all material was first fed into this primary crusher and from thence distributed in reduced size to the smaller gyratory crusher, it now became necessary to pick out smaller pieces of rock from the quarry and feed them directly into the gyratory crushers.

A new side frame would have cost from $2,000 to $3,000, not including the cost of machining it for installation, nor the loss of production, amounting to around $800 worth of trap rock per day, while awaiting the slow delivery of a new side frame. The casting was therefore inspected with a view to welding it, and as a Thermit welding repair was considered feasible, this method was chosen.

Preliminary Steps in Repairing Side Frame

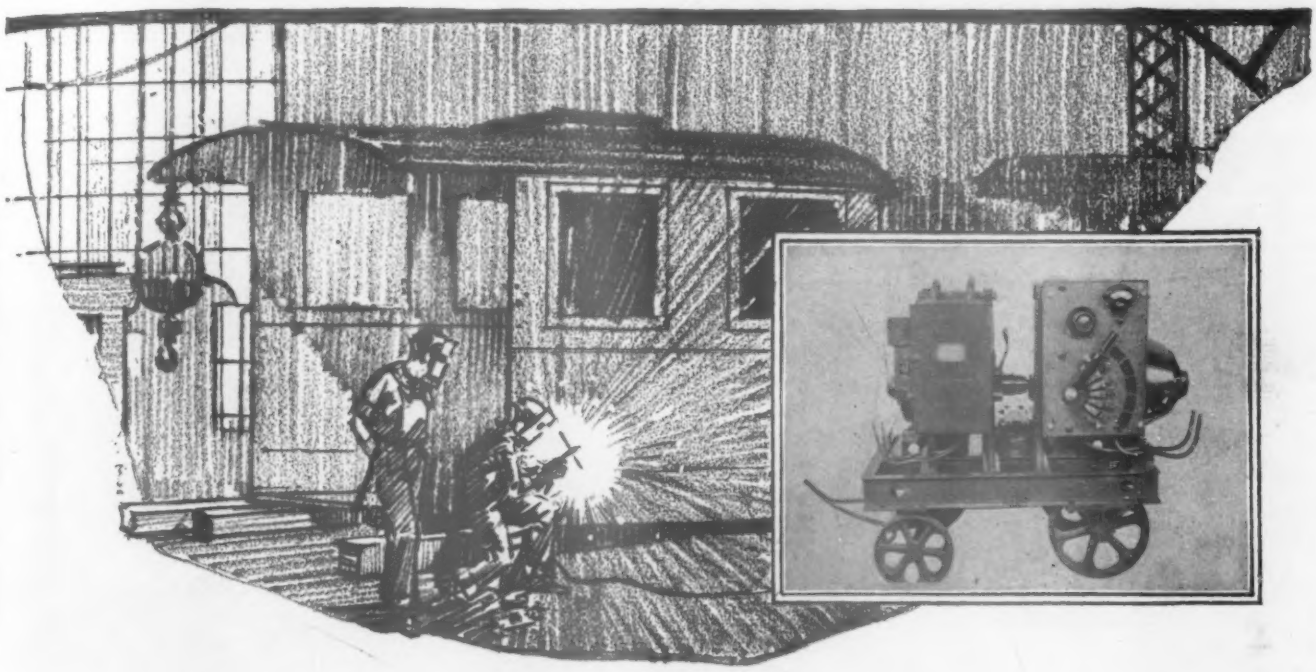
It would have been possible to weld the frame in place without removing it from the crusher, but as the machine had to be dismantled anyway to allow the other broken side frame to be replaced by a new frame which already had been ordered several weeks beforehand, it was decided to remove the casting and weld it outside the crusher building. The frame was propped in a vertical position by means of wooden beams. Small openings were then cut out at the broken sections by means of the oxy-acetylene torch in order to allow space for the steel generated by the Thermit reaction later to enter. After these openings were cut out the faces of the broken sections were chopped with a pneumatic chisel and thoroughly cleaned with a wire brush. The two interior pockets, which contained molding sand and chaplets used in making the original casting, were also carefully cleaned out.

Lining Up Broken Sections and Applying Patternwax

The next step consisted in lining together the two broken sections in order to bolt the end piece in position. Two 2-in. bolt holes were drilled through the end of the piece and the piece then bolted to a cross-rib in the side frame.

An opening about 2 in. wide was left between the two sections for the metal comprising the weld. After a trial adjustment the end piece was temporarily removed in order

The secret of building specialized equipment is to build it so that it will do the specific thing for which it is designed



Whether It's a Big Job or a Little One—Weld It

From the cab plates of a huge locomotive to the tiny seam on a nickel plated bathroom fixture, electric arc welding has won for itself a predominant place in production. It has provided a means of doing the old job quicker, at less cost, with greater strength and longer life than the ordinary bolted or riveted joint.

There is a G-E arc welding set for almost every purpose, whether it requires a portable or stationary, single or multi-operator, or automatic equipment. No matter if the available current is direct or alternating—G-E sets are built to suit either one, or may be driven by an engine or from a line shaft.

Every possible phase of welding has been studied by G-E engineers. Their experience and their knowledge should be helpful to any manufacturer who contemplates the use of electric arc welding. The school for welders at Schenectady is free and open to men desirous of learning practical welding.

Add to these facts the proven advantages of electric arc welding as a production, repair and salvage measure, and then put your own problem up to G-E Specialists. If you can profitably use electric welding, they will show you how. If you can't they will tell you why.

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to permit application of yellow pattern wax around the inside edges of the fracture, also to allow molding material to be rammed into the two 4-in. deep pockets. Meanwhile a hole was drilled through a horizontal rib in the small outer piece in order to facilitate escape of the hot gases when the weld was poured. The end piece was then readjusted and a layer of wax applied adjacent to all fractured parts. Care was taken to insert molding material rather than wax in the three frame bolt holes for bolting the side frame to the rear head.

Final Operations

A large square sheet iron box 39x36 in. at the base,59x55 in. on top and 74 in. high, was next built around the fracture and securely bolted in place. The inside of the box was then tightly rammed with molding material according to the usual method followed in Thermit welding. Three wooden heating gate patterns were inserted in each side of the mold box directly above one another. One riser pattern was inserted at the top of the fractured side frame. The function of a riser is to hold a supply of steel which will remain liquid for a considerable period of time and take care of all shrinkage, so that when a pipe is formed, due to shrinkage, this pipe will appear in the riser and not in the weld. Also, the riser acts as a depository for loose sand or other foreign matter which may be washed into it by the Thermit steel in passing through the mold and prevents this material from clogging in the weld. Owing to the large size of the fracture, three double burner preheaters were used to preheat the weld, the preheating also serving to burn out the yellow pattern wax from the mold and to dry out the mold. Preheating was started at 8 o'clock one morning and continued until 4 p. m. the same day. At this time 1,000 lbs. of Thermit, which is a mixture of iron oxide and aluminum, were placed in two crucibles suspended over the mold. A small amount of special ignition powder placed on top of the Thermit was then ignited, causing a chemical reaction to take place, as a result of which superheated liquid steel and slag (aluminum oxide) was formed in about 35 seconds at the intensely hot temperature of about 5,000 deg. Fahr. The liquid steel thus formed was precipitated to the bottom of the crucible. At the completion of the reaction the molten steel was tapped through the bottom of the crucible into the mold, thus supplying the metal for the weld.

Restoring Crusher to Service

Ample time was allowed for the weld to cool slowly. The mold was then dismantled and the riser and pouring gate metal cut off. Owing to lack of facilities for machining the weld on the inside where the rear head fits into a keyway, the metal at this point had to be chipped off with a pneumatic chisel. The welded side frame was finally reinstalled in the crusher and operation restored at full capacity.

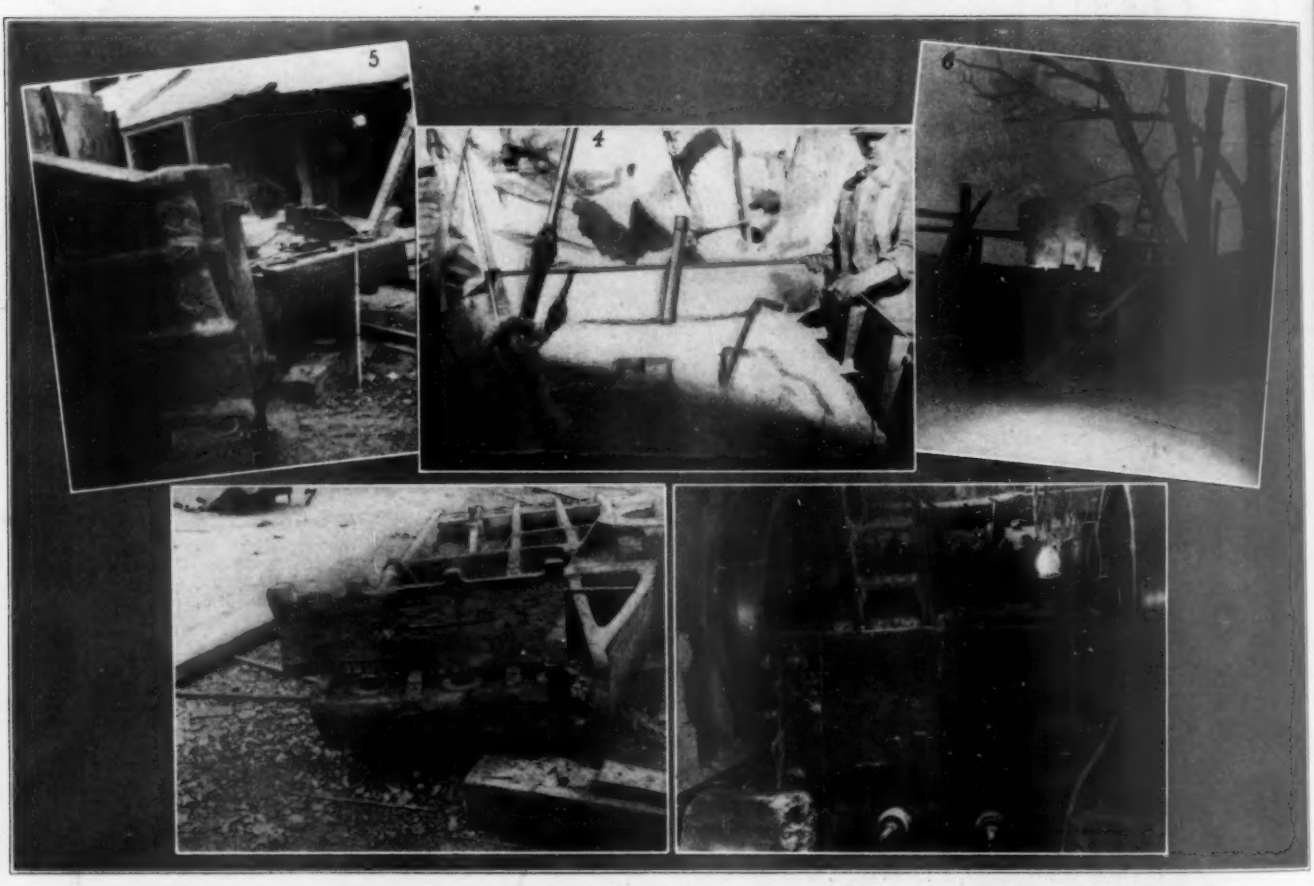
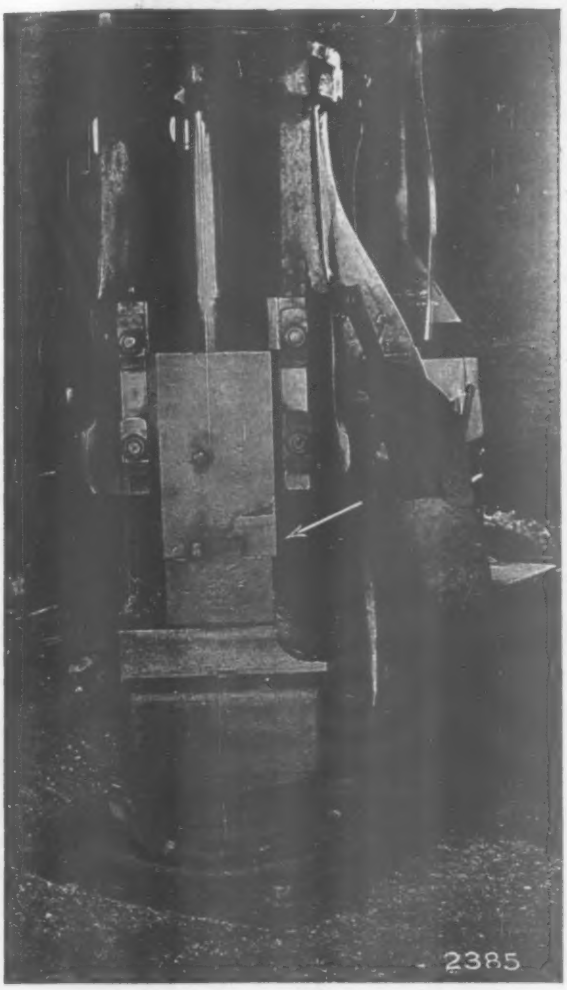


Figure 4. Top View of Rammed Up Mold Box, Showing Venting Rods, Pouring Gates and Riser Patterns.—Figure 5. Yellow Pattern Wax Applied to Outer Side of Fracture.—Figure 6. Thermit Reaction.—Figure 7. View of Broken Sections Before Cleaning Out Pockets. —Figure 8. Crusher Restored to Service in Pit.

Moving Pictures Taken of Repair

Moving pictures were taken of all the steps of this job. The setting where the repair was made proved to be admirable for the production of an interesting industrial film, for the scene was replete with incidents of local color, such as the work of dynamiting rock from the precipitous cliff behind the quarry, gathering up the rock and dumping it into cars by means of the almost human steam shovel ("supermen") and hustling the cars over to the crusher plant, where the material was rudely dumped into the greedy gullet of the gyratory crusher.

The repair is of particular interest because of the special problems involved in welding a hollow section of this kind and also because of the very severe strain to which the welded crusher side frame was subjected after having been installed in service.



Arrow shows Thermit weld made on ram of steam hammer

Read this account of a service test on a Steam Hammer Ram repaired by

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PINIONS
ROLLS

While overhauling a No. 2 steam hammer at the Springfield, Mo., Shops of the St. Louis-San Francisco Railroad the ram was found to be cracked where the top die fits into the head. The ram measured 8¼ in. x 24 in. x 16 in. wide. The ram was at first cut out and an attempt was made to have it oxy-acetylene welded, but a few months later started to crack again. A new ram was ordered but the old one gave way and broke off before the new ram could be delivered. A Thermit weld was then made, the weld machined and the hammer replacedin operation five days after the break. According to latest reports the hammer had been in operation for the past three months and was still in as good condition as ever.

The three months' service test was a severe one. There was a constant pound on the weld, as the hammer was used for forging soft steel car axles down to 1 in. x 4 in. size, also for other kinds of work.

If you have broken something, wire us, or 'phone our nearest office
Send for Pamphlet 1779

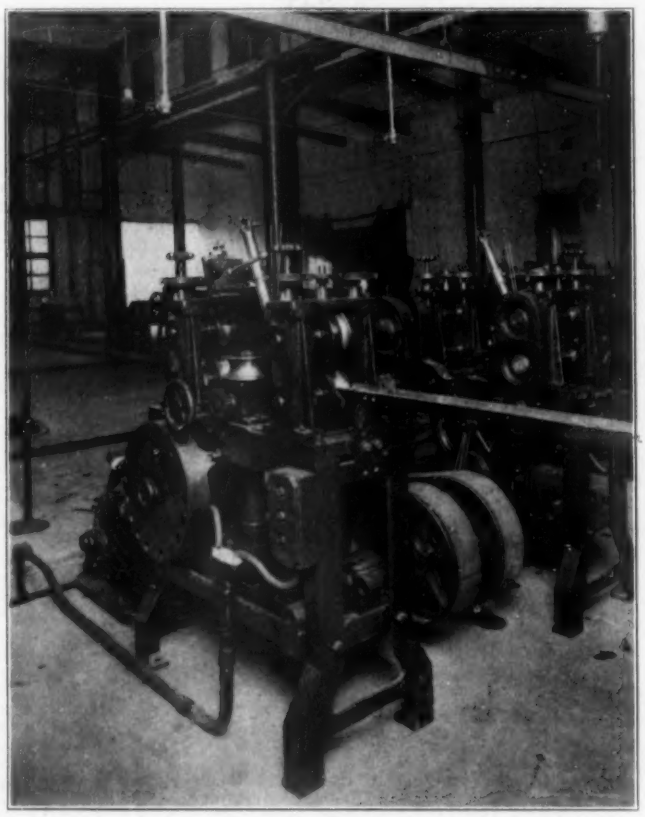
Metal & Thermit Corporation
120 Broadway New York

BOSTON PITTSBURGH CHICAGO SAN FRANCISCO TORONTO

POSSIBILITIES OF TUBE WELDING.

NUMEROUS articles of shop furniture have been made by oxy-acetylene welders from pipe, tubing and plates. Welding tables, preheating furnaces, vise benches, stools, ladders, water tubs, etc., are readily fabricated from pipe, or pipe and sheet steel. The limit to what can be produced with these materials and the torch is fixed only by the skill, imagination

Commercial products that can be produced from steel tubing are also limited only by the skill, resources and imagination of the manufacturer and his advisers. The applications of welded tubing in furniture construction for example are increasing, and the promise of the future is a far greater use of tubing than has ever been realized heretofore. The limitations to the use of thin gauge tubing in the past and at present have been the cost and scarcity of the supply. Light welded tubing can be produced, however, which for all practical requirements is as good as seamless tubing and much cheaper. It has the great advantage that the manufacturer may install the weld-



D-B Tube Welding Machine.

ing machines and apparatus for producing his own tubing from mill sheets or specially rolled strips. The investment of capital is not necessarily large.

The illustrations show some samples of tubes welded on the Davis-Bournonville tube welding machine, using the multiple flame machine torch, which have been subjected to severe physical tests. The integrity of the welds is indicated by the distortion to which samples have been stressed, and the soundness of the welds after such treatment. The tube welding machine produces a compression weld with little or no flash, and without adding material.

The equipment required for making oxy-acetylene welded tubing depends in the material to be used and the fabrication to which the tubing is to be subjected before leaving the tube shop. In some ways it is to the advantage of the manufacturer to be able to make tubing from commercial steel sheets. He is thus able to purchase his raw material in the open market. It necessitates the installation of a slitting machine for cutting the mill sheets into strips of the widths required. The lengths of tubing produced before any drawing is done are limited to the lengths of the mill sheets. On the other hand, if the tubing is produced from rolled strips, slitting is not required unless it is necessary to trim the strips to width in order to insure uniformity and smooth edges. The strips come in rolls, the length of which depends on the gauge and width. The advantage is that strip stock can be welded in lengths and cut to suit the fabrication requirements, whereas the tubing welded from mill sheets is necessarily limited to the length of the sheet, and the waste in crop ends is greater.

The stock, whether cut from mill sheets or rolled strips, must be form rolled preparatory to welding. From the tube forming machines the formed tubing goes to the welding machines where it is welded and from thence to the cutting-off machines which remove the crop ends. The welded tubes should then be inspected and any unwelded spots welded with hand torches. Having been inspected and defects corrected the tubes go to the grinding machines to have the slight ridge produced in welding removed. In case, however, of finishing by drawing, it will not be necessary to grind off the ridge as this will be smoothed down and eliminated in the drawing process. Drawing is accomplished with a tube drawing machine, the size of which will depend on the diameter and gauge of tubing to be handled.

The practice of tube drawing is a study in itself and it can only be touched on very briefly here. One important point to be considered, which saves expense and investment, is limiting the number of sizes of tubes welded and consequently the

Severe Tests on Welded Tubing.

number of welding rolls. One size of welded tubing can be made to produce several sizes of tubing by drawing it successively through reducing dies until the diameter required is reached. For many purposes the tubing will require surface drawing only, the flash on the inside not being objectionable, but for some classes of work, however, it will be necessary to draw the tubing over a mandrel, thus making the inside as well as the outside smooth.

Square and retangular tubes are produced from the round tubes using a mandrel or plug of the required shape to draw the tube over. It is first necessary to shape the round tube to the approximate rectangular shape required by swaging the end, but when the end has been swaged so that it will enter the die the remainder of the shaping process is done by the drawing die. Hexagonal and oval tubes are also made in the same manner. Hence, it is apparent that a manufacturer by installing a tube welding machine provides within his own control the means of production of round, rectangular, polygonal and oval tubing of all sizes and gauges desired. The amount of capital necessarily tied up in stock is quite limited, as any desired diameter, gauge or shape may be produced in the tube mill with a few hours' notice.

Another possibility of fabrication of great importance in furniture manufacture is applying the process of swaging to cylindrical tubes to produce tapered forms. There is almost no limit to what can be done with the swaging machine in the matter of tapering tubing. Not only can it be swaged to a taper, but it is also feasible to swage combinations of tapers, grooves, globes and other ornamental effects that are found useful in this industry.

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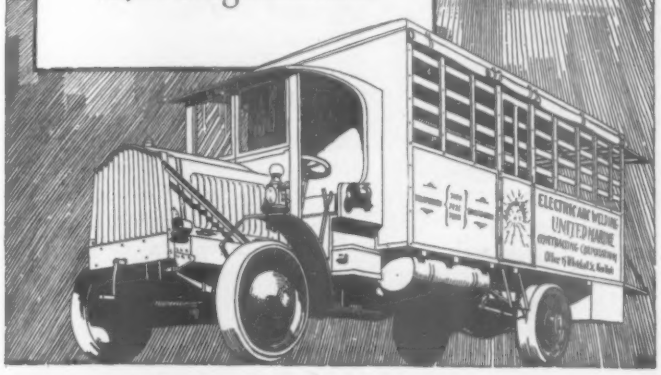

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Work for 1921

CONTINUED progress of the welding industry, such as it has enjoyed during the past five years, is possible and also quite probable. In the proceedings of the American Welding Society, in this issue of *The Welding Engineer*, will be found many problems which must be worked out as near to a finish as possible before welding processes will be universally used in all the fields to which they are adapted. What is the best design for butt welding plates? What current values are best suited for half inch plate? What is the best method of holding the torch in gas welding? What is the best method of procedure in welding long seams in sheet and plate stock? What should be taken as the most important basis in making specifications for welding wire? How shall operators be trained in large enough numbers to meet the demand for real good welders? The American Welding Society, through its various committees, will do some active work on all these problems this year, and they should be able to call upon the trade for co-operation with some assurance of getting it. Every bit of progress made by the society's committees will react to the direct benefit of the welding industry as a whole, and very likely to the direct benefit of a good many individuals who keep in touch with the work done.

Price Level Exception

IN REVIEWING the unexampled price situation of the past few years, a few bright spots stand out in gratifying contrast to the general inflation. Now that deflation is in progress, it is well to remember the exceptions to the general rule when the tendency was upward instead of downward, for in these instances there is no superfulness to deflate.

Among such instances, that of oxygen is especially notable, because commercial oxygen enters into industry in almost every productive field. Instead of mounting in price, the cost of oxygen to the consumer has actually been lower throughout the past five years than it was in 1915.

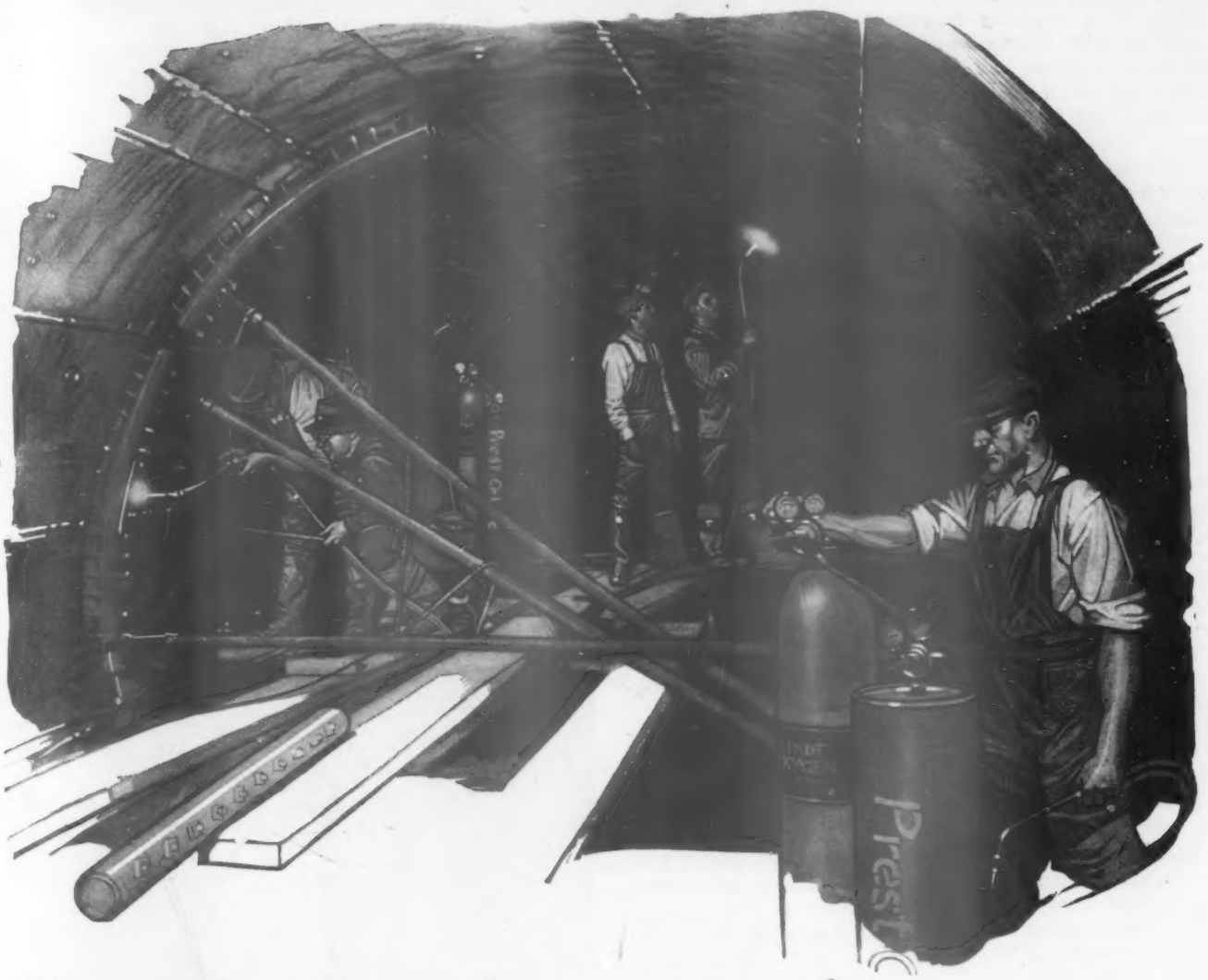
The trend of oxygen prices as compared to certain other commodity prices is graphically shown in a chart published in recent advertisements put out by one of the country's foremost manufacturers of oxygen. This producer believes that keeping oxygen prices below the 1915 level was not only a patriotic service to the government and its allies during the war, but that a continuation of the policy thereafter is good business—that it is certain to pay dividends in the encouragement it offers to a greater expansion and development of the industry in general.

Publicity Is Good for the Welder

LAST month the owner of a welding shop fitted up an attractive booth in a motor car show that was under way in his town. The automotive repair field is a good one for the welder, and it is not surprising that he picked up a number of new customers as a result of the exhibit. But he also secured a lot of new business from men outside of the motor field, visiting factory superintendents, who saw possibilities in the welding processes displayed. This welder's experience shows that welding is not as well known to the public as it should be. There is a heap of good business waiting for every shop as soon as the prospective customers are "shown." Many effective methods of advertising can be used to bring in new business. The best ones are those which display or illustrate work that is being done.

Safety First

A SHORT time ago a letter was received from a man who had been employed for several years as an electric arc welder, and who liked his work. His letter states, however, that his eyes have become so poor that he has been forced



Two miles of seamless copper tube a hundred feet underground!

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PW-504-21

to stop welding and look about for some other line of work. This is by no means an indictment against the process. It is only one more illustration that "Safety First" pays. Anyone who knows anything at all about electric welding knows that the rays of the electric arc are harmful, but that they can be intercepted and rendered harmless by the use of a shield or helmet. Yet some operators will persist in being careless of all warnings, and in this instance it means risking eyesight to save a very small inconvenience. All educational work with welders should include thorough treatment of the safety considerations, and welders should be watched to see that they are observing these points. There are workmen who would work in a gunpowder factory and smoke cigarettes on the job, but no industry can afford to let all these chaps learn the safety lesson by making mistakes.

A Too Frequent Error

IN A news item relating to the licensing of acetylene generators, a Chicago daily informs its unsuspecting readers that "Acetylene generators are used to create gases used in cooling systems and for the inflation of balloons."

The average news writers' proclivity for technical error, where acetylene is concerned, is often mischievous. The fact that the mischief results from unwitting ignorance does not help the case of acetylene. Primarily, definitely and finally, acetylene is not used for inflating balloons. Neither is it used for refrigeration. Lighter-than-air craft depend for buoyancy on either hydrogen or helium. In cooling systems the refrigerants are ammonia, carbon dioxide or sulphur dioxide.

Anent the mischief-making effects of inaccurate newspaper references to acetylene, may be noted the prevalent predilection of reporters for coupling the words "acetylene" with mysterious explosions. This tendency is so marked as to approximate an obsession. The nontechnical writer is all too careless in the use of technical terms, employing them, presumably, on the assumption that the public is as uninformed as himself on technical and scientific subjects. The mischief of the thing is in the fact that the lay reader may be unable to detect the error.

Some of the technical journals not long ago published an article entitled "Why Pick on Acetylene?" in which were pointed out a few typical instances of reportorial recklessness that should prove enlightening to the conscientious newspaper scribe. Apparently there is no means of reaching the jugglers of phrases to whom facts are constitutionally unimportant.

NEW ALUMINUM SOLDER

A new solder recently announced to the trade is called "Silverine." This solder comes in three grades. The "hard" grade is recommended for joints in lead pipe, copper radiators, steel auto bodies, cracked cylinder water jackets, etc. The "soft" grade is for jobs requiring a greater fluidity; and the "aluminum" grade is for general aluminum repair work. Silverine is made by the MacKenzie-Waterhouse Company, Transportation Building, Chicago, Ill. Mr. A. L. MacKenzie of this company was formerly located in Seattle, Washington, and the company has recently made its headquarters in Chicago. The MacKenzie-Waterhouse Company has no connection with L. B. Mackenzie, publisher of *The Welding Engineer*.

A THERMIT WELDING REPAIR WITH RISER BASES AT DIFFERENT LEVELS

A thermit welding repair, out of the ordinary as regards the arrangement of risers (for supplying liquid steel to feed into the weld during contraction) was recently made on a large cast steel hydraulic cylinder of a steam pump operated by the City of East Liverpool (Ohio) Water Works and Filtration Plant, shown in the accompanying illustrations.

The casting had become cracked in the location illustrated in Fig. 1, which shows the gap cut out by the oxy-acetylene torch. This crack extended about 20 inches. An attempt was made to repair the casting by oxy-acetylene welding, but a crack again developed as a result of contraction strains. The cylinder was then Thermit welded.

Figure 1. Gap Cut Out with the Torch.

In view of the fact that the bases of the two risers used were not in the same horizontal plane, the lower part of the riser having a lower base was made about 3 inches in diameter, as shown in Fig. 2, in order to supply sufficient steel to feed the

Figure 2. Lower Riser Made Three Inches Thick to Supply Right Amount of Steel.

weld. A 1½-inch in diameter riser, made thinner in order to reduce the amount ot steel required, extended above the chunkier section up to the level of the other riser, so that when the crucible was tapped the Thermit steel was poured on top

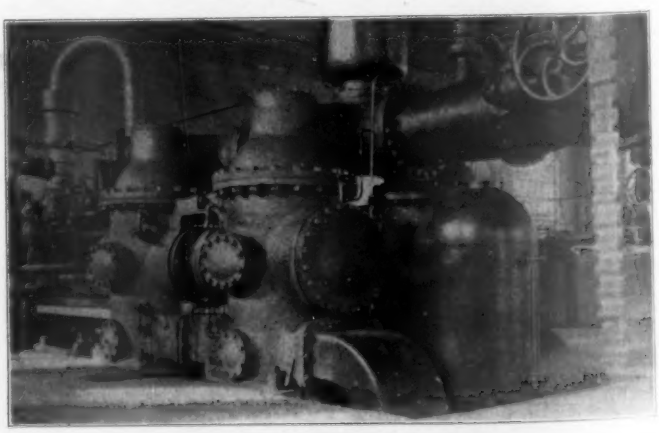

Figure 3. Cylinder Back in Service.

of the mold and allowed to run into both risers. Fig. 3 shows a view of the pump after the welded casting had been replaced in operation and was giving perfect satisfaction while being operated constantly under a pressure of about 130 pounds per square inch, pumping filtered water up to a reservoir.

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Hold on! What were you doing just then? Storing away that interesting bit of welding experience, or a photograph, perhaps? Don't do it? Give it to us. We want to show it to 5,000 other readers of The Welding Engineer (you're the fifty-one hundredth). If there are objectionable features to it, just leave it to the Editor (he studied surgery), cutting off and adding to is his hobby.

Another thing, when you work out a successful solution to a welding problem write us about it. Grammar and composition don't count—it's ideas we want. If a sketch would illustrate your job in good shape, just make a rough pencil sketch; our draughtsman will do the rest.

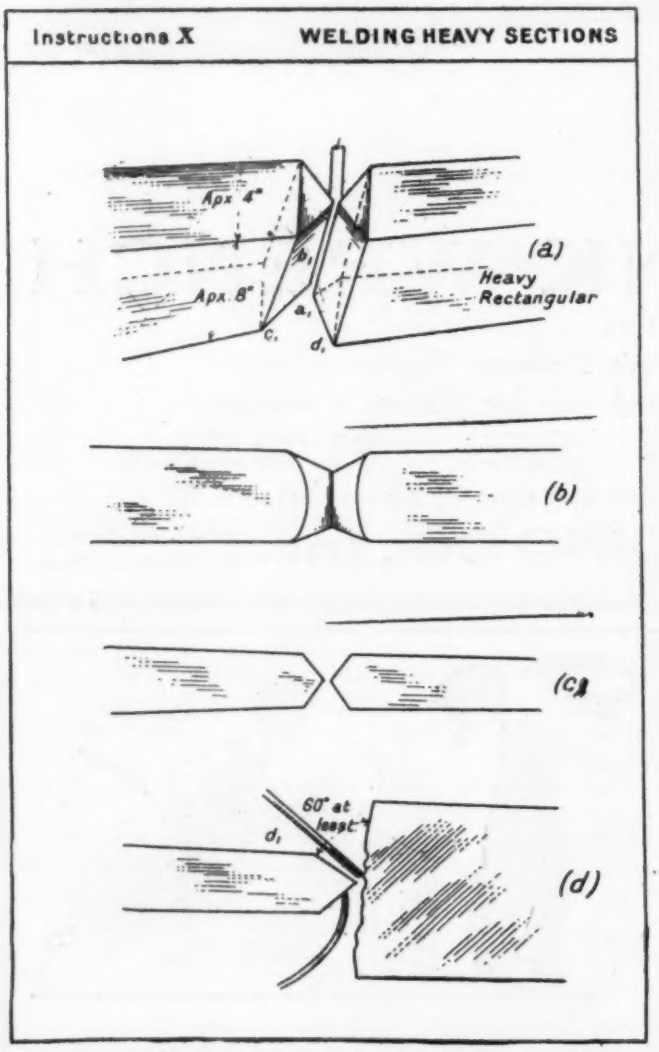
If the welding industry is to grow, you welders must pass along your experiences. We pay for them.

THE WELDING ENGINEER
608 S. DEARBORN ST., CHICAGO

WELDING HEAVY SECTIONS*

FIGURE A shows how a large section can be successfully joined by electric arc welding. It will be noted that the smaller dimension of the section is "veed" into a double V by machining or gas cutting or electric cutting; if the job is such that it can be turned, i.e., rolled over, a smaller or similar "V" should be made on the other two faces, and if it can be rolled over this "V" should be made on the top face, as shown in Fig. A, so that the length of edge abutting is somewhat reduced.

A section like this, however, should never be brought to a pencil point, as there is then infinite chance of its becoming



warped out of alignment during welding, whereas with a chiselled edge preparation of each piece, as shown, there are only two chances, when once properly lined up and tacked, of its being drawn out of line by expansion in welding. The piece should be tacked at the top, bottom and middle of the chiselled edge, and the entire length of the chiselled edge filled up from the side opposite to the tacking, then welding from the other or first side; add two or three layers or beads, proceeding from side to side, as in the direction A-1, D-1, A-1, C-1. When two or three layers have been added on this side proceed to the other side and add approximately twice as many, then proceed to the first side and add twice as many on the other side, and so on, by degrees, from each side until the job is finished. This is to prevent the original alignment being pulled out of place by the contraction of the welding method.

Where the two pieces of the parent metal or one of them is non-rigid, during the welding they may pull out of alignment, but if the welding is equally done and not too much increments from either side, the resulting alignment will be reasonably perfect. A way of insuring the alignment as near perfect as possible is to have two men weld at the same time and at the same rate, one from each side. This is especially applicable to large pieces symmetrically arranged, and where the time of one man welding would cover more than a day's work, or where rush work is required and costs must be sacrificed in welding a job of this nature. For subsequent machining it is practically impossible to have the weld and parent pieces in alignment sufficiently for machine fitting or bearing alignment. In this case one of the pieces, or both, should be larger than the finished size, or a pad of welding metal can be added all around, or on the low side, so that subsequent machining to the correct size can be accomplished.

The greatest care should be taken, however, in lining up the pieces so that this bead or excess of metal required should be a minimum. In welding a broken crank shaft by the use of "V" blocks passable jobs have been made without this addition in metal, yet it is much simpler and surer to pad the entire surface and machine all over to the correct size.

Figures B and C show the method of joining circular sections. Here the mistake is often made of preparing the two ends to a pencilled point instead of a chiselled edge. As explained, it is very difficult to get true alignment even with the chiselled edge preparation; with the pencil point preparation, or as might better be termed centre punch preparation, there is absolutely no chance of ending up even with a reasonable amount of padding or excess metal to be machined. This does not come from the inability to line it up perfectly from the beginning, but the impossibility to equalize strains in the welding metal. In welding large sections, too great a bite into the parent metal on either side of the "V" should not be made at once; i.e., the amount of the parent metal bit into in each layer should not exceed the width of one bead.

This for two reasons:

1. That too great a leverage for pulling out of line is not allowed.

2. If the parent metal is covered with the weld at the start the "V" after the second or third layer will become too narrow to do proper welding; i.e., to be able to hold the electrode at approximately right angles to the face to be welded.

Where the bottom of a large section is inaccessible a plate can be put at the bottom; starting either underneath and flat up against the section or the plate veed out as at C-1, A-1, D-1 to provide a foundation for the successive layers. A succession of these plates could be provided, successively welding one on top of the other until a laminated joint is made. This method is used by some engineers to weld engine frames, making the laminations up out of scrap boiler plates; while others are using the solid weld and fill in a section with an equal or better success. If the weld is properly made it is obvious that this is the better method as a 100 per cent section is thus obtained; whereas the laminated method is too similar to the process known as "slugging"—which should not be countenanced in any method of welding—but often used in filling in large sections or holes. It consists of putting in solid pieces of metal such as slugs, bars, washers or rivets and then filling in around with the weld and presenting at the finish an apparently beautiful job. Obviously the inner section is valueless and the job fails, in time to detect the guilty party. This process should not be mentioned to operators, as it is bad in practice—it will probably be met with sometimes. There are a few cases, however, where slugging is permissible:

1. Where a finished surface only is desired and no strength need result.

2. When a reinforcing member is added as a longitudinal bar welded along a member under bending strain, to reinforce its center section as a strut, where its bending moment is greatest.

If a job is welded and it breaks in the weld, and the weld

Instruction No. 10 from the handbook of the Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J. Copies of the complete instruction book may be had from this company at $1.25 each.

seems to be perfect, the break of the original bar and the breaking of the weld show that the section is not large enough. If a slight increase is necessary or allowable, it can best be put on by a pad of welded metal, but if a considerable length of section is to be put on, it is sometimes advisable to apply the section by new good metal welded by fillet or "veeing" to the size desired.

Figure D shows method of preparing a joint which is to be avoided. Sometimes it will be met, especially when joining to a section much larger, or to a flanged section where the break is very close to the flange. In this case the angle of the chiselled edge must be greater and more nearly equal to the double angle when prepared from both edges. Even when this angle is such, great care must be taken that the weld is made to the vertical heavy face carefully, and for this purpose sketch D shows how wire can be bent into a shape which will assist in this. A joint made in this manner has not the chance of being as reliable as a joint made as in A, B, and C, because more surface is available on one of the pieces to be welded to than on the other, and because there is no chance of an overlapping fillet on the larger piece, where it is most needed.

In the case where the large piece is cast iron or both pieces are cast iron, steel studs can be used, as shown in detail in the next instruction, their number and cross-sections being designed for reliability and strength of the two pieces to be joined.

Welding by the use of the arc, with both alternating current and direct current, is pretty well known on heavy sections, and among the jobs already in use are worn wobblers padded up and by use of the carbon arc hardened and smoothed at the same time; water-cooled fire door repairs; rolling stock repairs and bearing breakage; wear and accidents, including special locomotive jobs, such as flue welding, and miscellaneous breakage and wear, such as gear teeth, worn and broken keyways, worn armature shafts, misdrilled holes, lack of bosses and a multitude of jobs that can be handled by a "putting on" tool, the first of its kind.

A new development in arc welding as yet being applied only on heavy castings, is welding directly with a metallic electrode from ⅜ in. to ¾ in. in diameter and current values of 350 to 750 amperes, with this heavy rate of heat; i.e., 12 to 15-kw. at the arc, special handle, leads, etc., are necessary and so much metal is molten at a time and the temperature being generally higher it is practically imperative to use some oxide and nitride restraining flux. Because of the great majority of this heavy work being hole filling and speed being generally one of the results desired, the use of a slag-coated electrode where metal must be put down in layers, each layer being chipped off before another layer is applied, is out of the question, although this type of electrode has the effect desired of protecting the molten metal from the air for straightening head work, such as welding a calking edge. An electrode which protects the moten metal from oxidation and nitrogenization by chemical action; i.e., fluxing action passing off the oxides and nitrides as a gas, naturally fulfills better the protecting action necessary without brushing or chipping being necessary. Bare wire welding at these current values is out of the question if results reacting to the benefit of arc welding as a whole are desired.

In discussing alternating current and direct current cutting and welding, it is often said that because the temperature of the positive electrode is higher, that special work can be done with direct current apparatus. However, I would call the reader's attention to the fact that in either cutting or welding the tool electrode is always much smaller than the work electrode, and no one can conceive of the heat dividing equally between this one small area and the infinitely larger one of the work, so that in alternating current or direct current the heat is absorbed to the extent of over 90 per cent by the work, neglecting the air losses of a long arc. In the case of alternating current, although the current and voltage arc reciprocating, the heat energy flow is practically in one direction, that is, to the work.

PRACTICAL VALUE OF CAST IRON CUTTING

When the cutting of cast iron by use of the oxy-acetylene flame was first announced less than a year ago, it was thought that the new application, while very interesting from a scientific point of view, would not prove of great practical value. Even the manufacturers of equipment believed the field for application of the process would necessarily prove limited. It now appears that the field is much broader than was suspected.

From many quarters are coming reports of instances where the new process is resulting in very substantial savings. The latest case to evidence that cast iron cutting satisfies a definite need in industry comes from a New Jersey chemical company.

This company had in one of its buildings five large cast iron pots of an average weight of 25 tons. Two of these were no longer serviceable and it was decided to scrap them, but their great weight made removal to the scrap yard impracticable without first reducing them to smaller sections. This could not be done by breaking up the pots, owing to the limited space, and to chip them and crack with sledges would have required considerable time and expense.

Some time previously the company had purchased a cutting outfit, and it was remembered that the salesman had stated that cast iron could be cut with the torch. In the emergency a service man was called in consultation. He advised that the job could be easily handled and lost no time in starting the cut and in instructing the chemical company's cutters so that they could complete the job.

The procedure was to start the cut on the flange, cutting down for a distance of 3½ feet, then to cut horizontally for 4 feet, after which another cut from the flange to complete the cut-out of a block 3½ by 4 feet was started. Just before this cut was finished a crane was hooked onto the flange to prevent the piece from falling. In the same manner succeeding sections were removed around the flange until only the lower portion of the bowl remained intact. This part needed no further reducing to be easily hauled to the junk yard. The second pot was reduced in the same way.

The total amount of cutting on one pot was 63 linear feet, the metal walls being 3 inches thick. The time required for cutting one pot was 17 hours.

When the cost for labor and gases was computed it was found that the value of the scrap left a substantial balance of profit. Thus the application of cast iron cutting in this instance not only solved a difficult emergency problem resulting in economy of time, but actually paid cash dividends to the company employing it.

NEW RAIL BONDING MACHINE

A booklet received from the American Steel and Wire Company, Chicago, contains descriptive matter, illustrations, and blue prints of their rail bonding device. The type of bond used has a steel face welded to a drop forged copper terminal, so the weld to be made in the field is steel to steel. This is accomplished by an arc welding machine especially made for welding rail bonds in street railway or electric railway lines. The equipment consists of spirally wound resistance wire, assembled in a light, durable, ventilated metal frame, and thoroughly insulated from the frame. It is designed to operate directly from a trolley circuit, and is particularly applicable to the welding of rail bonds, fish plates, etc. It can also be used in industrial plants where the power lost in the rheostat is not objectionable. The unit is light in weight and is equipped with handles, making it easily portable. A range of welding currents can be obtained from 60 to 200 amperes with intermediate steps of fifteen amperes each.

A WELL EQUIPPED WELDING SHOP

The accompanying photo shows the welding equipment of the new plant of the Walter Murphy Motor Car Company at San Francisco.

There is a special welding table 8 feet by 3½ feet and 3 feet in height. It is supported on pipe standards and has a special fire brick top, with two special gas torches on the table.

There is also an oxy-acetylene welding outfit for general use in the shop, a traveling crane, drill presses, a grinder, and a small anvil. The entire arrangement is convenient and the equipment complete enough to take care of a great variety of work.

A Shop Equipped for First Class Work.

UNIQUE GAS CUTTING OPERATION.

An interesting problem in everyday engineering was very simply solved by an oxy-acetylene cutter who was called on to remove a 90-foot steel stack around which a chimney of masonry had been built. Steel stacks are usually associated with factories. This one happened to be a part of the heating plant of a church. After it had been in service a few years the boiler and furnace plant was enlarged and the old stack was not large enough to provide a sufficient draft. To afford the greater draft required a chimney of masonry was built around the original stack, leaving a free space of several inches around the outer circumference, the steel structure being left in place. It was found, however, that this did not correct the difficulty, and accordingly, it was decided to remove the old stack.

The problem was to accomplish this without destroying the masonry. There was not sufficient space to lower a cutter an oxy-acetylene cutter managed to make his way from top to base of the old stack on the inside of the latter. He found it a snug squeeze and too tight to use the cutting torch effectively. Notwithstanding this difficulty the operator succeeded in cutting off the stack at the base, which enabled him to hoist the shell a few feet with block and tackle. He then set up his torch equipment on the chimney cap and with the oxy-acetylene flame burned two holes in opposite sides of the plate just above the cap level, so that, by slipping a crowbar through and slacking the hoist the stack would ride suspended on the bar. The next step was to cut around the between the inner wall of masonry and the old stack, but stack a few inches above the bar and lower the section cut off to the ground. This was done, the tackle cable then being hitched to the crossbar, so the stack would be given another boost. The process described was repeated by successive stages, the pull becoming easier as the sections were removed. and in due time the last length was hauled free and lowered.

This operation appears rather primitive, but it is an excellent illustration of the value of first principles, however crude the mechanism or means employed, in handling awkward situations in the absence of special equipment. In this case it is doubtful if a mast or "stiff leg" of sufficient size to handle this job without sectional cutting would have been economical even had it been installed ready to do the work, for in any case the sheathing would eventually have to be reduced to scrap of charging box size or be abandoned as unreclaimed waste.

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PORTABLE WELDING EQUIPMENT OF UNITED RAILROADS

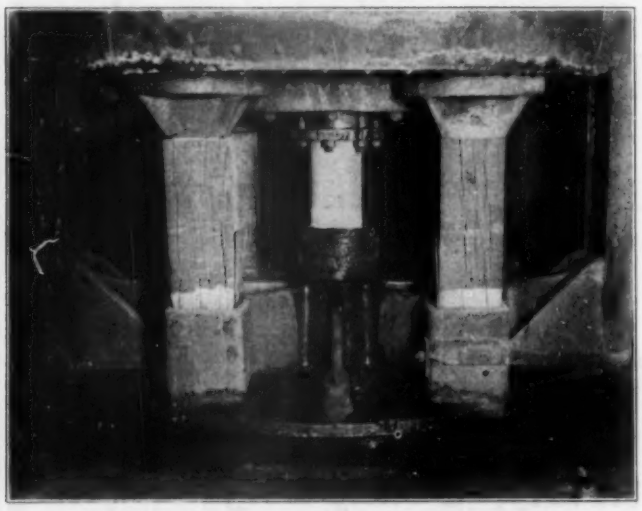
The accompanying photo shows a portable cutting torch, 2,000 pounds of oxygen, and 240 cubic feet of acetylene, which is used by the United Railroads of San Francisco in cutting

Portable Welding Outfit on the Job.

through rails and in welding axles, etc., the entire equipment being carried in a Ford motor truck. This equipment can be quickly transported to any part of the city for operation.

REPAIR OF HYDRAULIC ACCUMULATOR

An interesting repair of a hydraulic accumulator was recently completed by the Great Lakes Welding Company of Cleveland, Ohio. The accompanying photograph shows that the ram was reinforced all the way around at the base. The cylinder, which rests on supports, weighs 68 tons and when working the hydraulic pressure through the ram forces this cylinder up to about eight or ten feet.



Welding Saved a Three Month Delay Here.

This was a difficult job to handle, as it was welded in position and the total cost for overtime, traveling time and expenses, also cartage trip, amounted to $432, whereas the new ram cost $790 and they would have been out of use of it for at least three months and also the labor of taking down the cylinder and tearing out the foundation, which is in a cement casing.

When the job was completed the Great Lakes Welding Company received the following letter from the customer:

"The Great Lakes Welding Co.,
"Cleveland, Ohio.
"Attention Mr. Holt.
"Dear Sir:

"We wish to advise you that the welding of the ten-inch ram on our hydraulic accumulator, which was done by your company about thirty days ago is a success and we are of course very much pleased.

"We do not hesitate to state that owing to the fact that this ram is cast iron and the internal working pressure is 1,500 pounds per square inch, that we did not expect you would make a job of it. However, we were agreeably surprised. Your being able to make this weld has saved us many hundreds of dollars in the expense of repairs to the accumulator, as well as the production of all of our hydraulic riveters and flangers for several weeks, and we assure you we appreciate very much the prompt and efficient manner in which you handled the job.

"Yours very truly,
"THE REEVES BROTHERS COMPANY,
"G. H. Newton, Works Manager."

LICENSING OF WELDERS

Editor:

For some time I have been reading *The Welding Engineer* and have found some very good articles. I have noted the many comments you have published on the subject of licensing welders. I think it should be done. But licensing a welder doesn't make a welder; nor will it better conditions—if anything it would set us back instead of ahead. What would we do with the welders who couldn't stand the test? Where would we get welders to replace them?

No, we will have to start at the bottom and work up. I have been welding, mostly all pressure welding, for three years on locomotive fireboxes in the railroad shops, and I know what a man has to be to become a good welder. I will say for the benefit of those who don't know that no man can become a welder in three weeks or three months, and the sooner everyone realizes that the sooner the welding industry will step to the front.

I think the welding industry should progress very much faster. What good is any product if there is no labor to use it efficiently and successfully? My idea of the welding trade is this: First, establish welding as a trade; welding is not blacksmithing or boilermaking nor machinist's work—it is welding; second, organize the welders as a craft. Organizing would be the least of our troubles, as I think 95 per cent of the welders are strong supporters of the welding game and would not hesitate to help it along.

Our most difficult problem is the railroads. Approximately 60 per cent of the welding done in this country is done on the railroads, and in the railroad shops we have the national agreement and the shop crafts to deal with. The boiler makers are our hardest customers. They realize what welding is doing to their trade and they want to grab all the welding they can.

There are only two ways to go about it. Either go before the wage board as a craft for a hearing and incorporate with the national agreement as a craft if possible or affiliate with the A. F. of L. and get representation as a trade. After we get that it will be very much easier to make a real welder making all new men serve an apprenticeship, the same as any other trade. The American Welding Society could help draw up a standard form of books and credentials on expansion, contraction, different metals, etc., for the schooling of an apprentice. I would like to see this or some similar movement get started. And I would also like to read other welders' ideas about it. There are about forty welders here, mostly in railroad shops and I can assure you 100 per cent support to a separate craft, and am pretty sure you will find it the same all over the country.

C. Hoffman.

Patented
Jan. 22, 1918
May 4, 1920

Better Welding

—and good, steady production often are merely a matter of eye-comfort to the welder. The Willson Triangular Welding Goggle, Style L1, keeps out all sparks and permits free ventilation. Equipped with latest features. All parts can be replaced without a tool. Price $300.00 per hundred, f. o. b. factory.

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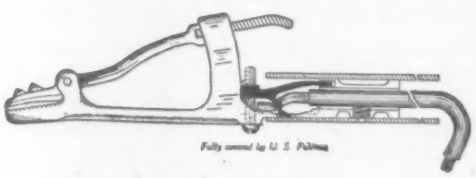
The world's largest factory making goggles and respirators exclusively.

Air-Cooled

Electrode Holder That Grips At Any Angle

THE UNIVERSAL



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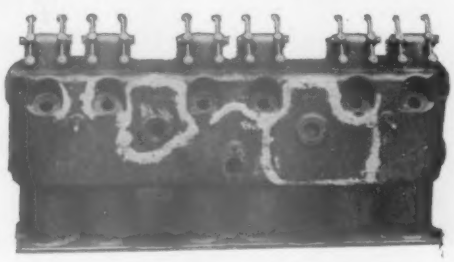

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WELDING GEAR HOUSINGS AND ENGINE BLOCKS

The accompanying photo (Fig. 1) shows a special rack for holding gear housings for welding. The housing is supported

Support for Gear Housings.

in such a manner that it can be turned in an entire circle enabling the welder to easily reach all parts for welding.

At each end of the rack there is a handle (shown at arrow) by means of which the rack can be quickly carried from place

Table Holds Engine Blocks at Convenient Height for Welding.

to place. The rack is supported on two dogs when the welding is being done.

Figure 2 shows a special welding table for supporting engine blocks for welding, the top of the table being made of fire bricks.

BUILDING UP FROG POINTS

Editor:

You railroad welders who are building up worn switch points, frog points and broken flanges, just try this on your welds. When a frog comes in to be repaired and has a point worn down, you prepare to weld it, probably heating the point some by building a small charcoal fire around it, while welding, or heating it up to a dull red with a kerosene blow torch, which saves much gas. Then you start welding at the point and work back over the ball, saving gas also by starting at the hotest place first and carrying the heat along as you work.

I find it best to work six or eight inches at a time building it up, hammering and dressing it off to finish. Then try this little process. Heat your finished surface again to a dull red, then adjust your torch to a carbonizing flame about one inch long and play slowly across the finished surface four or five times, not allowing the flame to come too close to the rail. Be sure to cover all parts evenly so as the rail absorbs carbon equally. If the point is thin do not play the flame too long there for the point being thin will absorb carbon too rapidly and will make that part brittle. After that start welding another six or eight inches and try the same process on the finished surface. When you are all through welding and the surface has cooled down, take a file and test the weld. What do we find? Why, simply this: the rail is hard, durable and has the strength of good steel, with a wearing surface that does not pound down the first time the driver hits it. It is not soft as your old weld used to be. Try it for yourself and see the difference.

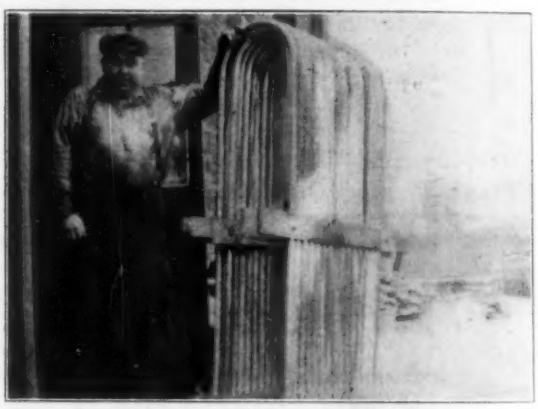
H. C. Speakman.

WELDED ALUMINUM CONDENSER

Paul Welding & Machine Co., Syracuse, New York, recently delivered to one of the largest chemical plants in the country a set of nitrogen condenser coils, made entirely of aluminum.

This job is so unusual, and is of much interest, and further proves that the feats that can be accomplished by oxy-acetylene welding are unlimited, in fact one feels that few operations are really impossible in production and reclaiming by welders who have made their profession an art and a science.

The above is a concrete example of what can be done. In



A Good Example of Skilful Welding.

fact oxy-acetylene welding is the only method that could be used in fusing the tube ends into the heavier aluminum body.

Twenty-nine 13 ft. lengths of 1½-inch aluminum tubes, with a solid aluminum bed plate, 20x30"x1½" thick, were used to form the above condenser. There were 29 coils 5 ft. 7 in. in heighth, making 14 inside coils and 15 outside coils all of which were welded to this large bed plate, and when completed every coil was in perfect unison, and not a leak in the entire condenser.

This remarkable feat was accomplished by Mr. James A. Brown, chief welder at the Paul Welding & Machine Company's plant, who operate one of the largest and most up-to-date welding shops in New York.

Mr. Brown became interested in the art of welding when the industry was in its early infancy, he made oxy-acetylene welding a study to develop the art to the highest points of efficiency and at that time there were no instruction books or instructors and he was obliged to do his own experimenting, and develop himself to produce the desired results.

Mr. Brown is to be congratulated for his many years of most efficient service as a welder. If all welders who enter the field, would make welding their study as has Mr. Brown, what greater feats would be accomplished, and what a boom for the industry.

Photographs and information were furnished by Mr. F. J. Ledger, representative of the Davis-Bouronville Co.

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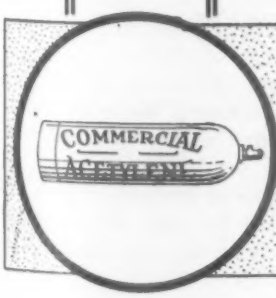
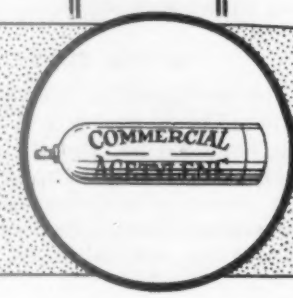


Commercial Acetylene



STEAM SHOVEL CASTING GAS WELDED.

The steam shovel is a heavy duty device and is constructed to stand up under severe working stresses. Even so it is not uncommon for some working part to give way in the racking service to which the mechanism is put, and at such a time the oxy-acetylene torch is the first aid of the competent repair man.

Chalk Marks Show Location of Welds.

The end sill casting for a large steam shovel repaired by welding is shown in the illustrations. It is a hollow steel casting about 8′ long, 3′ high and from 10″ to 20″ wide, with walls 1½″ thick. The casting recently cracked in a dozen or more places when subjected to an overstrain. Some of the pieces were small fragments that broke out and were lost. Like the old shay of the rhyme it had done yeoman service only to give way everywhere at once.

Repaired Steam Shovel Casting.

To replace the broken casting with a new one would have kept the equipment idle for several weeks. In the emergency the cracked and broken casting was shipped to the Oxweld Acetylene Company, Newark, N. J., and was repaired by welding in that company's job shop in short order. It was promptly shipped back and was immediately returned to service, easily saving the cost of the repair in the time gained over replacement delay.

STRAP SUPPORTS EYE SHIELD

The accompanying photo shows a device that has been perfected by an employee of the United Railroads Company of San Francisco for protecting the eyes while making electric welds on the street car tracks.

It consists simply of a board attached to a strap, the strap being slung around his neck. Several colored glasses are inserted into one end of the board with a clamp, so that the glasses can be easily removed for replacement. The welder holds the board in front of his face with his left hand and carries on the welding with his right.

This enables him to not only observe his work, but he can quickly glance up and watch out for passing street cars or vehicles. He can hear the approach of vehicles and the street

Strap Supports Shield When Not in Use.

cars readily. It also enables him to wear his hat at all times. When a street car approaches he drops the board, which is slung by a strap around his neck, and instantly has both hands free to remove the box on which he is sitting and his tools from the track.

This has proved so popular that the company has provided all its welders with this device.

AMERICAN WELDERS IN GERMANY

Editor:

I am sending you a picture of the Welding Shop Mechanical School, American Forces in Germany, which was taken a short time ago. Since this picture has been taken an acetylene generator has been installed, and the entire shop is now in

An American Welding School in Germany.

operation. Instruction is going on and I am happy to say that we are getting exceptionally fine results.

Very truly yours,

C. E. Hobbs,
Staff Sergeant, Mechanical School.

MORE ABOUT BACKWARD WELDING

Editor:

I have read with much interest the articles in your February and December issues on "backward" welding.

It appears from the articles that the word "sheet" is at times applied to material that in the United States is called "plate"; "sheet" being applied to metal not over ¼ inch thick, and usually less. So care should be taken in reading the translation. I should say that I have not seen the original.

"Sheet" and "plate" in what follows, will be used in accordance with common practice in this country.

It is common here to weld metal of ⅛ inch thick or less, without the use of welding wire. This is especially true of barrels and similar light weight containers. All barrel welding machines that I know of work forward, and use no wire. The same method is followed by hand welders, but does not make as smooth or as even a seam. I have seen a machine weld a 35 inch seam in 1½ minutes in 18 gauge stock. I have done the same work by hand in 2 minutes and I am not expert at it. Both welds will stand the beading used on barrels, so there is no reason for using wire.

I do not believe it is impossible to do this work "backward." But I seriously doubt that it is as fast as working forward. I have never been able to do it as quickly, and I know of no place where it is done.

On the other hand, for plate work I have used the backward method for seven years, and I know welders who have used it for over 10 years. So it is nothing new in this country, and many welders can confirm my statement.

I abandoned the forward welding on plate, because I could not get as good welds as by backward welding. Others may be able to get good results by it, but no weld made that way, that I have seen, is as good as welds made the other way.

It is to be noted that no complete tests have been made by the author of the article. And until such are made and published, it would seem premature to claim its superiority in the matter of the 60° angle, which I have not found to be practical, unless the plates are separated, when of course, the 60° bevel approaches more or less to a 90° angle with the edges of the bevel touching, depending on how much the 60° bevel edges are separated.

It would be very interesting and instructive to examine carefully specimens of the welding done as described, not for tensile strength, but for soundness, that is, freedom from laps and adhesions.

Yours sincerely,

S. W. Miller.

Editor's Note: Our translator evidently fell down on the proper use of the terms "sheet" and "plate," a failing that is quite common among translators. The article referred to was reproduced in *The Welding Engineer* so our readers could see what our friends in Paris are talking about. The backward method of welding has considerable merit in its field and is not so well known to young welders as it should be.

DOES NOT FAVOR EXAMINATION FEE

Editor:

Replying to Mr. Wass' letter in the September issue of *The Welding Engineers,* in regard to licensing of welders.

I am very much in favor of Mr. Wass' idea in licensing welders, but am not in favor of the law making power in delegating a committee from the American Welding Society who are not practical, experienced men in welding, to be the examiners. I think it would be best to appoint the examiners from experienced men.

I would like to call Mr. Wass' attention to the so-called "plasterers," as he states in his editorial. I do not think Mr. Waas should criticise the plasterer, because the man that they call the "plasterer" has not had the proper training in welding and, therefore, should not be criticised on his work, but the criticism should be passed to the manufacturers of the equipment and their demonstraters.

We have demonstraters today going out demonstrating welding equipment who know very little of welding. If the law-making power should examine welders to have license to operate welding equipment, there would not be enough men licensed to operate the welding equipment at the present time.

Would also like to call Mr. Waas' attention to the man being examined be compelled to pay a fee to cover this examination and if, failing in his examination, would forfeit his fee. I am not in favor of this fee being charged for men being examined. When a fireman or brakeman on a railroad is going to take an examination they do not have to put up a fee to cover their examination, and, therefore, do not approve of welders putting up a fee to be examined.

I believe Mr. Waas ought to be broad minded enough, if he is an experienced welder, to show the best methods of welding and when he sees a so-called "plasterer" and sees that he is doing his welding wrong, he should by all means show this man the right way to do the job. He will never get anything by criticising other men's work.

Yours very truly,

C. T. Green,
Foreman Welding Department.

Editor's Note: Although Mr. Green evidently desires to be fair to everybody in discussing the subject of a license for welders, his statement that the American Welding Society is composed of men who are not practical or experienced welders is too broad to pass without comment. On the contrary the society is probably able to furnish a committee of practical, experienced men better able to decide upon examination procedure and tests than could be found anywhere else. The American Welding Society has the full support of all the leading manufacturers of welding equipment, and of many large users of welding processes, and its membership includes scores of *welders,* men whose daily occupation is the handling of the torch or the arc.

ERNEST EDWARD WHITE

We have learned with deep regret of the death of Mr. Ernest Edward White, treasurer of the Union Carbide Sales Co., at St. Luke's Hospital, Chicago, February 28, 1921.

The news of his death comes to a host of friends as a great shock, his illness was of so short a duration as to take him away from his business affairs a few days before the end.

Ernest Edward White.

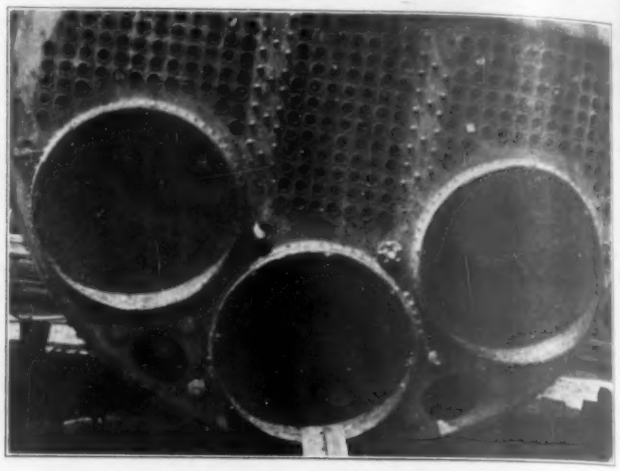
Mr. White, who had been actively connected with the carbide industry since its very inception, had been treasurer of the Union Carbide Sales Co. since its organization in 1906.

He is survived by his wife, Helen Webster White, two brothers, and four sisters, to whom *The Welding Engineer* extends its sincere sympathies in their bereavement.

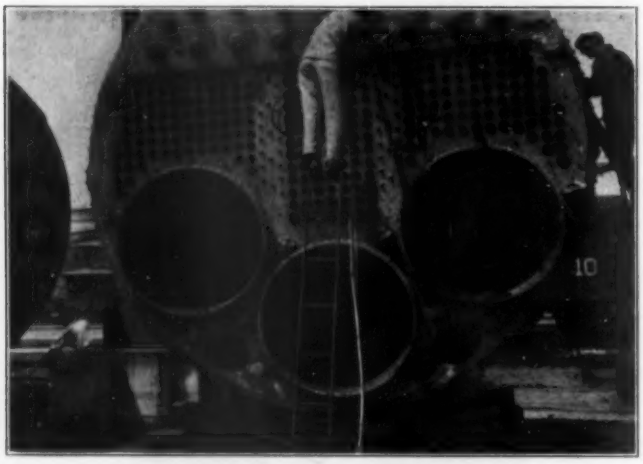
SCRAPPING MARINE BOILERS

A cutting operation on four large Scotch marine boilers is shown in the four accompanying illustrations. The work was done by H. T. Henning & Co., Philadelphia, Pa. The boilers were removed from a vessel originally owned by the Merchants & Miners Transportation Company, plying between New York and Savannah. The weight of each boiler was estimated at about forty tons and the work on the four boilers was completed by two men in a period of twenty days. After the boilers were dismantled the material was cut in shape and resnipped to various mills for remelting. When the job was completed Mr. Henning sent to the Air Reduction Sales Company a highly commendatory letter, acknowledging their good service in delivering oxygen for use in the cutting.

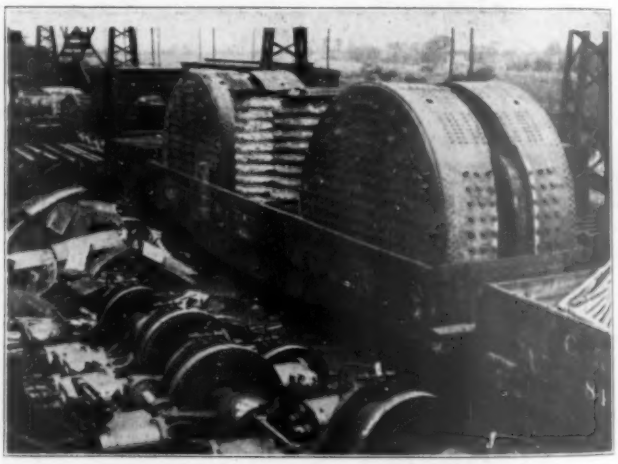
Two Men Cut Up These Four Boilers in Three Weeks.



Close-up of One of the Boilers.



Cutting a Monster Boiler.



Scrapped Boilers Ready for Shipment.

"A LITTLE BETTER THAN GETTING AWAY WITH IT"

By F. A. Bennyhoff

This article is intended for the benefit of those who have welded punch presses and as usually is the case have experienced more or less difficulty in keeping the alignment. Our shop recently welded a large punch press and in doing so was so successful in overcoming the usual difficulties in preparing and keeping the alignment, that I take the liberty of writing a brief history of the job in the hope that it will be of some benefit to others.

The press was an upright Erin punch press weighing two tons, both uprights being 8½ inches square and completely broken off 3½ inches from base; the face plate being between the insides of the uprights and part of the base. The base to be kept at right angles with guide face and four feet from it.

It was at once seen that if these uprights were prepared in the usual way by V'ing both ways from the center it would create a hinging point and, having such a heavy base, difficulty would be encountered in keeping it from swinging or pulling out of line. Accordingly, both uprights were prepared by V'ing 45° from center on same side so as to be able to do one-half of the welding in one position, leaving the other half of each upright unprepared.

Then a large one inch U bolt was thrown around the entire casting and across base with nut on each end of U bolt in order to draw the two halves of unprepared fracture into their original positions.

The first half of welding having been completed the casting was rolled one-quarter (¼) turn and the other halves of fractures cut out with cast iron cutting torch while red hot (cast iron being cut more readily when red hot). The casting was then turned one-quarter further bringing the V's on top, reheated and welding completed with perfect alignment as a result.

By the use of a large floor preheater we were able to cover the casting and allow it to heat during the night, thereby enabling us to complete the first half of the welding during the morning of the first day.

In the afternoon we turned and prepared the casting to be reheated during the second night and the welding completed the second day.

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Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

Wanted—Salesmen, Demonstrators, Welders and others meeting the welding trade to solicit subscriptions to *The Welding Engineer*, or furnish names of possible readers. When you put your friend or customer in touch with this publication you do him a real favor—make it possible for him to learn more about autogenous welding, liberal proposition. Write me now. Yours for welding, Mackenzie.

For Sale at Attractive Prices—Prest-O-Lite Service Agreement on 10-WK. cylinders. Address 42, care *The Welding Engineer.*

FLUX FORMULAS for Cast Iron, Brazing, Copper and Aluminum. We will mail the FOUR guaranteed formulas for $4.50. Write today. American Flux Co., Box 153, Madison Square Station, New York City.

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Make your own Cast Iron and Aluminum fluxes. Satisfaction guaranteed. These are the better kind. $4.00 for all three. Pacific Flux Co., 18 Natoma St., San Francisco, Calif.

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We can furnish you with a SCORED CYLINDER MATERIAL with complete instructions for applying the same at $4.00 per bar, experience not necessary, our flux does the trick. Mail certified check, express money order or postoffice order. Wilkes-Barre Welding Co., Wilkes-Barre Pa. Established 1910. 2t Feb.-Mar.

First-Class Portable Electric Welding Outfit For Sale Cheap—Lincoln gasoline driven motor, mounted on 5-ton Knickerbocker truck, connected with air compressor and 1,000 feet of cable and hose and tools, with van body—all in good working order. Used very little. Address Bournonville Welding Co., 241 West Sixty-fourth Street, New York City.

Found—A way to stand in with the boss. Use "U. S." WELDERS MOULDING COMPOUND, make neater welds in less time. 5-lb. carton with directions, $2.50. Mfgd. only by UNITED STATES WELDING CO., INC., Minneapolis, Minnesota.

For Sale—One 200-lb. Duplex Generator, one ten-cylinder Manifold, ten low pressure Welding Stations. Additional equipment to make installation complete. Manufactured by Oxweld Acetylene Company. This is new equipment, has never been installed. If interested write The Hoover Suction Sweeper Company, North Canton, Ohio. 2t-Mar.-Apr.

Wanted—To buy a paying Welding Shop in a good location. Address 56, care The Welding Engineer.

WANTED

OXY-ACETYLENE SALES MANAGER to take complete charge of district sales office of large acetylene apparatus manufacturing concern. Must have had experience in oxy-acetylene sales development work. Knowledge of prospective field and how to reach it necessary. State experience, age and other qualifications. Address 57, care The Welding Engineer.

For Sale—3 Davis Bournonville torches, $35.00 each; 9 Acetylene Regulators, $15.00 each; 8 High Pressure Oxygen Regulators, $18.00 each. Perfect condition. The United Welding Company, 1772 Main Street, Bridgeport, Conn.

Position Wanted—By first-class welder and mechanic. Four years' experience. Address 58, care The Welding Engineer.

Position Wanted—By experienced electric welder. Chicago or St. Louis preferred. May or June. Would consider foreign work. Employed at present. Desires change on account of climate. Address 59, care The Welding Engineer.

Position Wanted—By welder with two years' experience; oxy-acetylene welding and cutting and electric arc welding. Prefer small town in middle west. George Ray, 5152 W. Kinzie St., Chicago, Ill.

For Sale—Four WC Prest-O-Lite Cylinders, $30.00 each; one Prest-O-Lite Cylinder, $60.00. Address 60, care The Welding Engineer.

Position Wanted—By oxy-acetylene welder with nine years' experience. Have references from Mare Island, Navy Yard, Union Oil Company and Southern Pacific Railroad Company. Have worked as instructor of boiler welding and as salesman for Western Oxygen Co. Address Earl De Santis, Fellows, Calif. (General Delivery.)

Position Wanted. Electric welder with five years experience on boiler and generator repair work. Prefer Chicago location, but willing to leave city if opportunity is a good one. Address Henry Thessenvitz, 1319 W. 14th Place, Chicago.

For Sale. One 50 lb. Oxweld acetylene half duplex generator. Guaranteed as good as new. Price, $300.00. Bock Bros., 113 So. 12th St., Fort Dodge, Iowa

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The Waters Arc Welding Corporation, New York, has been incorporated with a capital of $100,000 by H. A. Miller, F. C. Lord and A. K. George, 166 West Seventy-seventh street, to manufacture welding apparatus.

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CURRENT WELDING LITERATURE

CUTTING CAST IRON WITH OXYGEN.—An analysis of the methods proposed by Mr. F. J. Napolitan and Prof. A. S. Kinsey. The author regards the cutting of cast iron as due more to local melting of the metal than to the formation of oxide, and considers the chief value of the jet to lie in the fact that it blows the molten metal away and clears more surface for the torch to melt. He also suggests that if experience shows a necessity for burning by means of oxygen it is possible that some flux which would facilitate the melting of the oxide might be advantageously employed. —Industrial Gases, December.

REBUILDING ACETYLENE INSTALLATIONS.—Acetylene generating apparatus which has been idle for a long time should be completely dismantled and examined before being put in service again. All bearing parts should be properly lubricated and all joints tested. Surfaces should be painted if it appears at all necessary. Any parts about which there is any doubt or which are worn or rusted through should be replaced by new parts. Finally, charge it and thoroughly test for leaks.—Journal de L'Acetylene.

PREPARATION OF ALUMINUM CASTINGS, by W. B. Purdue. —The preheating temperature should be brought up slowly and the metal carefully watched. If the metal will light a piece of newspaper or char sawdust it is near the melting point. If it sounds flat and dead when tapped with a light hammer it is hot enough to start welding. It is safer to preheat the whole casting than to localize the preheating. Have the fire slow and even and protect the metal from draughts. Watch it closely when near the melting point. Cool as slowly as possible.—Acetylene Journal, March.

TORCH VERSUS FORGE, by David Baxter.—Story of a downcast blacksmith who complains that trucks have put horses and blacksmiths out of the business until an apparatus salesman shows him how much profit he can make by repairing trucks with the oxy-acetylene torch.—Acetylene Journal, March.

OXWELD CAN DO IT.—Published by the Oxweld Acetylene Company, Newark, N. J. Illustrated with halftones portraying typical applications of welding and cutting processes in various branches of industry. Five pages of text are devoted to a general outline of the range of work with the torch in production, repair and salvage.

ELEMENTARY MACHINE SHOP PRACTICE, by J. A. Pratt. —320 page illustrated text book presenting the elements of the machinist's trade. The processes described are related to the bench, lather drill press, shaper, slotter, grinder, miller and planer. The text includes a machine glossary and a set of useful tables. Published by D. Van Nostrand Co., 8 Warrent St., New York City.

POSSIBLE ECONOMIES IN THE APPLICATION OF THE OXY-ACETYLENE PROCESS.—It is suggested that the purity of carbide be tested and generating plants be watched to see that none of the gas is wasted through excess production. A close check on the contents of oxygen cylinder tanks is recommended. Finally, the torch should be selected with a view to getting the type and size best adapted to the work.—Canadian Welding Journal, February.

ELECTRIC ARC WELDING IN THE WESTWOOD PLANT OR THE RED RIVER LUMBER COMPANY, by C. A. Britton.—A list of some of the repairs made by means of the electric arc that illustrates the extent to which the method can be applied by lumber companies and similar industries. Detailed descriptions of typical jobs are illustrated with photographs.—Metal Trades, February.

ELECTRIC WELDING, by Ethan Viall. Contents: Electric Welding, Historical; Arc Welding Equipment; Different Makes of Arc Welding Sets; Training Arc Welders; Carbon-Electrode Arc Welding and Cutting; Arc Welding Procedure; Arc Welding Terms and Procedure; Examples of Arc Welding Jobs; Physical Properties of Arc Fused Steel; Metallography of Arc Fused Steel; Automatic Arc Welding; Butt-Welding Machines and Work; Spot-Welding Machines and Work; Welding Boiler Tubes by the Electric Resistance Process; Electric Welding of High Speed Steel and Stellite in Tool Manufacture; Electric Seam Welding; Making Proper Rates for Electric Welding, and the Strength of Welds. 417 pages. Published by McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y.

WHY MR. COOK WEARS THAT SMILE

Mr. H. W. Cook, Editor of The Acetylene Journal, has announced with justifiable pride the arrival of "the finest little baby girl in the world" at his home. A self-appointed committee, consisting of Mr. W. H. Bleecker and Mr. Don B. McCloud, has discussed the question of a suitable name for the young lady and recommend that she be christened "Hydrogen." Congratulations, Harold!

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At the annual meeting of the stockholders of the California Burdett Oxygen Company, March 9, the name was changed to California Compressed Gas Company. Also at the recent annual meetings of the following companies:

The Burdett Oxygen Company of Colorado,
The Utah Burdett Oxygen Company,
Washington Burdett Oxygen Company,

the several corporate names were changed to

Colorado Compressed Gas Company,
Utah Compressed Gas Company
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respectively. All of these companies are subsidiaries of the Compressed Gas Corporation of Denver.

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For acetylene or electric welding of chrome nickel steel.
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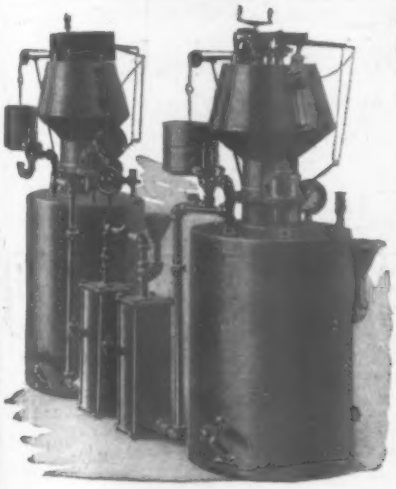

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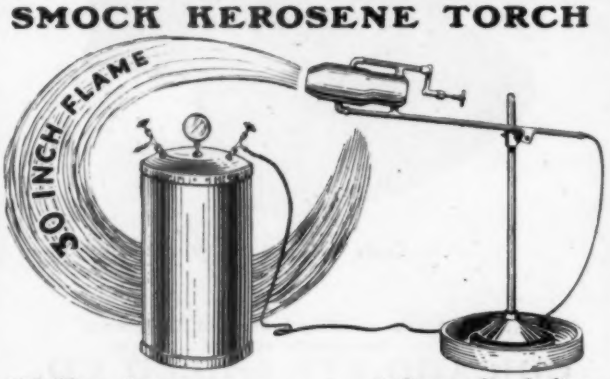

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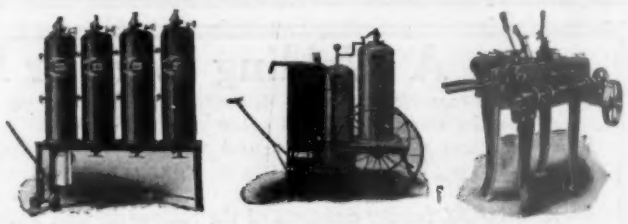

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Mention The Welding Engineer when writing.

Chicago, Ill.
February 14, 1921.

Editor, The Welding Engineer,
Chicago, Illinois.

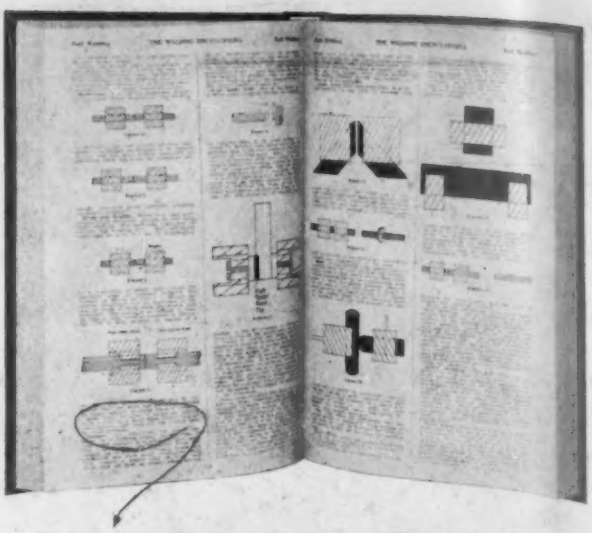
Dear Sir:—

I have a technical problem at hand that I trust you will find it possible to answer or have answered. I wish to manufacture a new demountable rim which must carry several small lugs. These pieces may be made most economically by having them cast, and the question is whether or not it is possible to have these cast pieces welded electrically to the body.

Will you kindly answer this question for me, and oblige,

Yours very truly,
R. G. A.

Can He Weld It?



Page 136 of The Welding Encyclopedia speaks of the resistance method of welding cast iron as follows:

Cast Iron. Because it turns so quickly from a solid to a fluid when raised to high temperature, cast iron can be welded only in small sections.

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